STATE OF ALASKA
William A. Egan, Governor

1969 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:
Michael L. McCurdy

1972

ADF&G TECHNICAL DATA REPORTS

This series of reports is designed to facilitate prompt reporting of data from studies conducted by the Alaska Department of Fish and Game, especially studies which may be of direct and immediate interest to scientists of other agencies.

The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revision will be made via errata sheets. Major revisions will be made in the form of revised reports.

1969 Bristol Bay Sockeye Salmon Smolt Studies

A summary of data collected from sockeye salmon
(Oncorhynchus nerka) smolt programs on the
Kvichak, Ugashik, Naknek, Egegik and Wood rivers

Edited by

Michael L. McCurdy
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1969 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES [1]

By

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ABSTRACT

The 1969 season is the sixteenth year that an index has been obtained on the sockeye salmon smolt migrating down the Kvichak River. The index is used for forecasting age composition of adult returns, and to evaluate smolt production from various escapement levels. The index was obtained in the same manner as in past years.

A total expanded 24-hour index of 1,135,344 smolt was obtained of which 52.3 percent was Age I and 47.7 percent was Age II. The contributing brood years were 1966 and 1967. Index catches began on May 23 and they ended on June 18. The largest catches occurred from May 30 to June 3.

Age I smolt were larger than average while Age II smolt were somewhat below average.

Water temperatures which are believed to be a factor affecting peak outmigration were lower than any previously recorded for the project.

Another site at the lower end of Kaskanak Flats (Site 5) was again fished in 1969 to evaluate the index net catch. For this purpose a new metal fyke trap was used.

New sonar equipment will be used during the 1970 season for the first time for the purpose of obtaining a total outmigration estimate.

A pilot smolt distribution study was conducted to determine if there was any sorting of smolt by age group, or a non-random route selection in a river cross-section. Catches were small due to lack of fish and area covered by the capture gear. Due to these small catches the only conclusion reached was that smolt utilize primarily the area of maximum velocity in a stream cross-section.

INTRODUCTION

This was the sixteenth consecutive year an index has been obtained on relative abundance of sockeye salmon (Oncorhynchus nerka) smolt leaving Iliamna Lake. Information obtained from these indices is used to predict magnitude and age composition of adult returns to the Kvichak River. This data is also used to evaluate smolt production from various levels of adult escapement.

The indices, however, have proven to be unreliable as a source of information from which to predict adult sockeye returns to the Kvichak. Factors producing this unreliability are smolt which migrate beneath the ice from lake break-up, irregular river bottom contour, two channels at the operations site, and annual variations in water level, turbidity, and light intensity. The last factor influences the amount of net avoidance exhibited by the smolt.

The index project has, however, provided some information on population dynamics of the Iliamna Lake system sockeye and its continuation is necessitated by need of comparative annual data.

A federally funded program, using funds from the Commercial Fisheries Research and Development Act (P.L. 88-309), was initiated in 1965 to improve the index or obtain an outmigration estimate. A brief discussion of this program will be presented in the Total Smolt Outmigration Estimate section of this report.

CONTINUATION OF THE INDEX PROJECT

Methods and Procedures

This year, as in all past years, a standard 4 foot x 4 foot fyke net was fished in the same location (Figure 1) and at the same depth. The standard fishing depth is 3.8 feet. Fyke net fishing began on May 23 and ended on June 18. Twenty-four hour sampling began on May 25. All fishing lost was due to

FIGURE 1. Kvichak River sockeye salmon smolt study area, 1969.

Lake Iliamna

Kaskanak Flats

Site 5

Igiugig

Otter Island

Index Site

Kvichak River

Big Rock Site

Levelock

ALASKA

Branch River

Scale: 1" = 4 miles

-3-
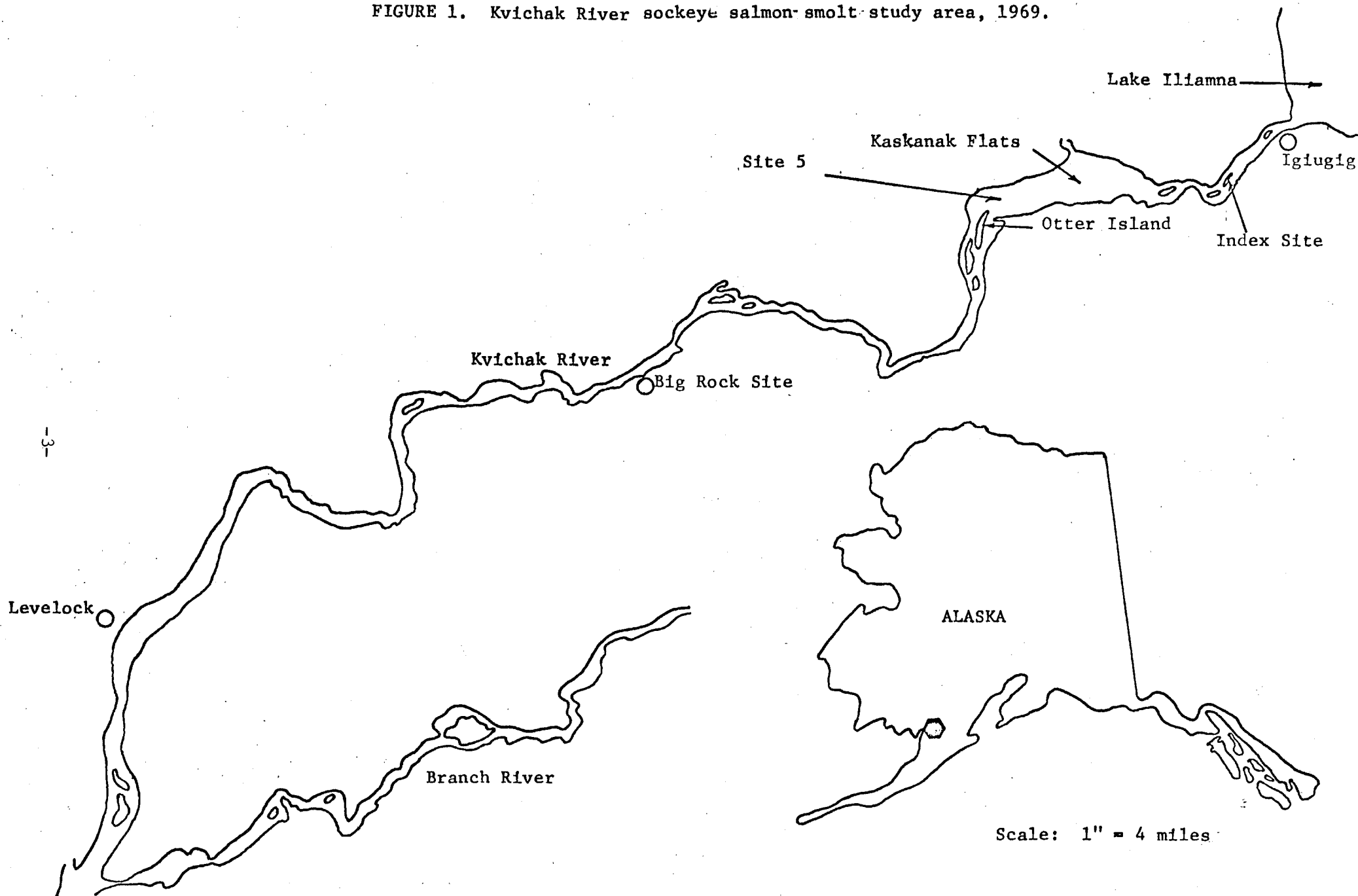
ice, algae, high winds and detritus.

Results and Discussion

Ice interference, climatological and hydrological data

A total of 101 hours were lost due to ice and/or high winds. Dates, hours lost, and the causative factors are presented in Table 1.

Table 1. Fishing hours lost due to ice and wind interference, Kvichak River, 1969.

Date	Fishing hours lost	Factor
5/25-26	8	Ice
26-27	4	Ice
27-28	13	Ice
28-29	15	Ice
29-30	22	Ice
30-31	4	Ice
6/ 6- 7	5	Wind
7- 8	22	Wind
8- 9	8	Wind
Total	101	

The procedure for taking weather observations was expanded in 1969 to include two daily observations on the water gauge. The gauging station was located one mile downriver from the Iliamna Lake outlet.

Water temperatures ranged from a low of 32.5° F. to a high of 46° F., with a mean seasonal temperature of 41°. The water temperature, on May 23 at the beginning of the outmigration, averaged 38° F. (based on the day's two temperature readings). However, the major peak of outmigration occurred when the average water temperature was 34° F. This is 2° lower than any previously recorded temperature for the beginning of peak smolt outmigration. However, as in past years, no substantial outmigration occurred until lake break-up began.

Tables 2 and 3 show weather and stream observations taken in 1969. In addition to this algae and detritus necessitated frequent cleaning of the fyke net.

Table 2. Climatological observations - Kvichak River, 1969, May 16-June 18.

Date	Sky 0900	Sky 2000	Precip. 24-hr. 0900	Precip. 24-hr. 2000	Amt.	Wind dir.-vel. 0900	Wind dir.-vel. 2000	Air temp. °F 0900	Air temp. °F 2000	Min.
5/16	–	4	0.00	0.00	0.00	–	NE 11	–	39	–
17	1	1	0.00	0.00	0.00	E 25	NE 19	41	37	–
18	1	1	0.00	0.00	0.00	NE 11	NE 6	41	45	–
19	3	1	0.00	0.00	0.00	N 9	SW 5	39	50	27
20	3	–	0.00	–	–	SW 13	–	43	–	27
21	4	4	0.00	0.00	0.00	NE 20	NE 18	49	46	34
22	1	2	0.00	0.00	0.00	NE 15	NE 2	45	36	–
23	2	4	0.00	0.03	0.03	S 12	–	49	47	–
24	4	3	0.03	0.00	0.03	NE 9	–	43	48	38
25	1	1	0.00	0.00	0.00	NE 5	SW 8	54	49	–
26	1	1	0.00	0.00	0.00	SW 12	SW 20	55	–	37
27	2	2	0.00	0.00	0.00	NE 19	0	48	44	33
28	4	–	0.05	–	–	E 18	–	44.5	–	33
29	2	4	0.01	0.00	0.01	NE 17	N 9	58	46.5	36
30	3	4	0.02	0.00	0.02	NE 18	NE 14	44	42	38
31	4	3	0.08	0.01	0.09	SE 8	SE 5	48	57	36
6/ 1	3	2	0.02	0.00	0.02	SE 16	NE 8	49	49	39
2	1	3	0.00	0.00	0.00	SW 8	SW 18	56	51	33
3	4	–	0.00	–	–	S 10	–	47	–	40
4	3	4	0.00	0.00	0.00	N 5	NE 5	56	46	36
5	4	4	0.01	0.00	0.01	NE 20	NE 18	49	43	41
6	3	4	0.00	0.00	0.00	NE 23	NE 18	44	43	41
7	2	4	0.00	0.00	0.00	NE 19	NE 20	53	43.5	42
8	3	3	0.01	0.00	0.01	NE 30	NE 15	49	47	42
9	3	3	0.00	0.00	0.00	NE 6	NE 8	54	49	40
10	4	4	0.00	0.00	0.00	NE 20	NE 13	47	47	42
11	3	4	0.00	0.13	0.13	NE 8	NE 14	52	42	41
12	4	3	0.21	0.00	0.21	NE 12	0	46	49	41
13	3	–	0.00	0.00	0.00	NE 8	–	57	–	40
14	1	–	0.00	–	–	NE 13	–	65	–	42
15	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–
17	3	4	0.00	0.04	0.04		NE 11	–	–	46
18	4	4	0.00	0.02	0.02	NE 25	NE 13	–	–	44

Codings: Sky

1 Clear sky, cloud covering not more than 1/10.
2 Cloud covering not more than 1/2 sky.
3 Cloud covering more than 1/2 sky.
4 Complete overcast.
5 Fog or thick haze.

Table 3. Hydrological observations – Kvichak River, 1969, May 16–June 18.

| Date | Water temp. °F | | Water gauge | | Turbid. |
	0900	2000	0900	2000	0900
5/16	–	35	–	–	C
17	37	37	–	–	A
18	37	38	-0.10	–	A
19	36	40	-0.10	–	A
20	37	–	-0.09	–	A
21	34	32.5	-0.02	0.06	B
22	35	35	0.12	0.04	A
23	37	35	0.25	0.17	A
24	35	38	0.18	0.22	A
25	35.5	41	0.26	0.27	C
26	36	43	0.28	0.22	B
27	32.5	33	0.21	0.44	B
28	38.5	–	0.56	–	C
29	34	33	0.46	0.50	B
30	34	34	0.57	0.58	A
31	38	41	0.56	0.57	B
6/ 1	40	40	0.56	0.68	A
2	41	42	0.61	0.61	A
3	40.5	–	0.62	–	A
4	41.5	42	0.70	0.90	A
5	42	44	1.05	1.16	C
6	41	43	1.12	1.12	C
7	42	42	1.06	1.36	B
8	41	43.5	1.52	1.32	C
9	42	42	1.04	1.18	B
10	41.5	44	1.31	1.38	C
11	42	44.5	1.12	1.22	A
12	43	44.5	1.22	1.26	B
13	45	–	1.22	–	B
14	46	–	1.24	–	A
15	–	–	–	–	–
16	–	–	–	–	–
17	–	46	–	1.75	A
18	–	44	–	1.94	B

Water gauge set at -0.10' at 1545 hrs. on May 17, 1969. Bench mark at 8.00'.
Water level 8.10' below bench mark.

Turbidity

Secchi dist. Reading in inches or:

A – Clear
B – Partly cloudy
C – Cloudy
D – Debris

Index Net Catch

This year's expanded 24-hour index net was 1,135,344 or equal to 34.0 index points. Major peaks of outmigration occurred on May 30-31, and June 1-3. Two other minor peaks occurred on May 27-28 and June 4-5. Two major peaks accounted for 45 percent of the total index catch. The two lesser peaks accounted for 19 percent of the total. Together they totaled 722,371 smolt. Figure 2 depicts daily index catches.

Catches for the index hours (2200-0100) totaled 543,351 (47.86 percent of the total) or 16.3 index points.

The total expanded catch is shown in Table 4. This was derived as described in Alaska Department of Fish and Game Informational Leaflet No. 83, with the following exception. When only part of a period was missed (i.e., 0100-0900), and no catches were made for the same period on either previous or following days, the average of the catches made during the portion of the period fished were applied back to the hours of that period which were not fished.

Photo-electric Counter Calibrations

The method of calibration was the same as used in past years.

Fishing with photo-electric counters began on May 31 and terminated on June 12. Daily conversion ratios for numbers of smolt per photo-electric count ranged from 5.25 to 7.66. The seasonal average was 6.55.

The seasonal average of 6.55 fish per count is the lowest ratio attained since 1965 when the average was 5.61. In 1964 a seasonal ratio of 6.36 was obtained. However, of these three years, only 1964 is comparable with this year in fish per minute passage rates.

The seasonal average ratio for this year represents an arithmetic mean of daily average ratios which are in themselves arithmetic means of fish per count ratios taken for that 24-hour period.

Due to lack of fish during the hours of 1500 to 1700 only three calibrations were obtained during the season. These calibrations were discounted in expanding daily net catches as they had highly variable fish per count ratios (11.25 to 1.04). Table 5 shows 1969 calibration data.
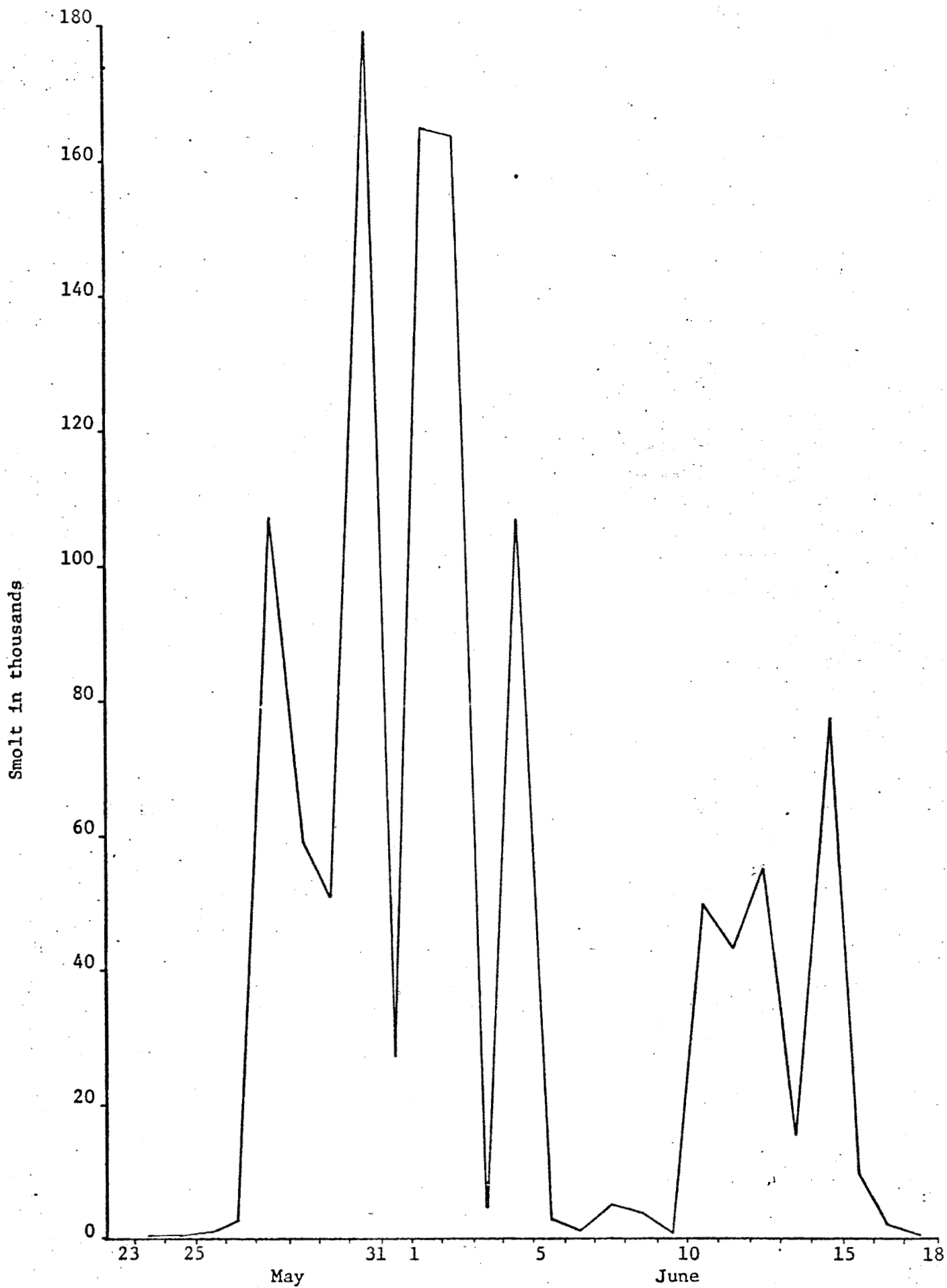
FIGURE 2. Daily fyke net catches of sockeye salmon smolt, Kvichak River, 1969.

Table 4. Kvichak River sockeye salmon smolt expanded twenty-four hour index catch by period, 1969.

Date	Index hours 1200-2200	2200-2300	2300-2400	0000-0100	Index total	0100-1200	Daily total	Accumulative total
5/23-24	-	-	3	-	3	-	3	3
24-25	-	-	-	3	3	-	3	6
25-26	24	12	1	9	22	1,098	1,144	1,150
26-27	16	130	5	958	1,093	1,869	2,978	4,128
27-28	1,130[1/]	178[1/]	28	327	533	105,705[1/]	107,368	111,496
28-29	2,249[1/]	1,480	12,360[1/]	23,240	37,080	19,580[1/]	58,909	170,405
29-30	4,790[1/]	13,057[1/]	13,057[1/]	13,057[1/]	39,171	7,041[1/]	51,002	221,407
30-31	7,324[1/]	11,168	9,895	20,201	41,264	131,098[1/]	179,686	401,093
31-6/1	15,624	4,697	123	12	4,832	7,197	27,653	428,746
1-2	3,930	34,743	80,879	28,214	143,836	17,244	165,010	593,756
2-3	16,218	97,464	48,958	1,087	147,509	30	163,757	757,513
3-4	727	1,108	2,231	67	3,406	184	4,317	761,830
4-5	138	3,625	26,490	27,145	57,260	49,152[1/]	106,550	868,380
5-6	1,507[1/]	100	111	377	588	876[1/]	2,971	871,351
6-7	615[1/]	16	39[1/]	62	117	230	962	872,313
7-8	2,860[1/]	46[1/]	46	46[1/]	138	1,991[1/]	4,989	877,302
8-9	60[1/]	11	6	4	21	3,743[1/]	3,824	881,126
9-10	442	9	1	38	48	61[1/]	551	881,677
10-11	21,853[1/]	4,433	3,898	222	8,553	19,070	49,476	931,153
11-12	28,372[1/]	529	588	770	1,887	13,168	43,427	974,580
12-13	43,055	299	172	667	1,148	11,095	55,298	1,029,878
13-14	12,498	6	758	600	1,364	1,914[1/]	15,776	1,045,654
14-15	4,656[1/]	21,060	25,834	4,993	51,887	20,909	77,452	1,123,106
15-16	2,460	525[1/]	525[1/]	525[1/]	1,575	5,919[1/]	9,954	1,133,060
16-17	1,817	4	3	5	12	142[1/]	1,971	1,135,031
17-18	305	0	0	1	1	7	313	1,135,344
Total	172,670	194,700	226,011	122,640	543,351	419,323	1,135,344	
Percent	15.21	17.15	19.91	10.80	47.86	36.93	100.00	

1/ Partially or completely interpolated data, refer to page 7 for method used in the interpolation.

Table 5. Kvichak River sockeye salmon smolt photo-counter calibration data, index site, 1969.

Date	Hours	Fishing time [1]	Weight [2]	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily average fish/count
5/31-6/1	2200	6.23	15.0	44	660	100	16.05	105.9	6.60	
	2200	1.02	8.4	44	370	120	117.65	362.7	3.08	
	2200	23.95	9.8	43	421	60	2.50	17.6	7.02	
	2300	46.67	1.9	46	87	11	0.24	1.9	7.91	6.15
6/1-2	2200	3.12	12.8	49	627	110	35.26	201.0	5.70	
	2200	3.02	16.7	44	735	100	33.11	243.4	7.35	
	2200	2.53	17.1	50	855	100	39.52	337.9	8.55	
	2200	10.45	27.5	46	1,265	200	19.14	121.0	6.32	
	2200	2.05	39.7	49	1,945	250	121.95	948.8	7.78	
	2200	3.12	28.4	47	1,335	200	64.10	427.9	6.68	
	2200	2.92	28.0	50	1,400	210	71.92	479.4	6.67	
	2300	0.85	31.3	51	1,596	200	235.29	1,877.6	7.98	
	2300	3.82	36.0	50	1,800	200	52.36	471.2	9.00	
	2300	2.28	33.4	45	1,503	200	87.72	659.2	7.52	
	2300	0.55	34.6	45	1,557	200	363.64	2,830.9	7.78	
	2300	2.08	35.8	52	1,862	210	100.96	895.2	8.87	
	2300	0.77	33.9	45	1,526	200	259.74	1,981.8	7.63	
	2300	1.17	67.2	43	2,890	380	324.79	2,470.1	7.60	
	0000	1.67	35.9	48	1,723	210	125.75	1,031.7	8.20	
	0000	3.15	33.4	45	1,503	200	63.49	477.1	7.52	
	0000	1.68	33.8	50	1,690	200	119.05	1,006.0	8.45	
	0000	18.50	28.8	55	1,584	190	10.27	85.6	8.34	7.66
6/2-3	2200	1.22	33.7	47	1,584	210	172.13	1,298.4	7.54	
	2200	1.83	18.3	53	970	200	109.29	530.0	4.85	
	2200	1.25	19.1	60	1,146	200	160.00	916.8	5.73	
	2200	1.93	17.9	55	984	200	103.63	509.8	4.92	
	2200	0.52	71.9	50	3,595	400	769.23	6,913.5	8.99	
	2200	0.40	58.3	46	2,682	360	900.00	6,705.0	7.45	
	2200	0.43	65.6	50	3,280	330	767.44	7,627.9	9.94	
	2200	0.58	26.2	38	996	200	344.83	1,717.2	4.98	(continued

1/ In minutes
2/ In pounds

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Table 5. Kvichak River sockeye salmon smolt photo-counter calibration data, index site, 1969 (cont.).

Date	Hours	Fishing time[1]	Weight[2]	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily average fish/count
6/2-3	2300	2.18	10.9	37	403	100	45.87	184.9	4.03	
	2300	1.07	22.4	42	941	200	186.92	879.4	4.70	
	2300	1.08	18.1	49	887	200	185.18	821.3	4.44	
	2300	0.57	26.3	47	1,236	200	350.88	2,168.4	6.18	
	2300	0.45	28.1	56	1,574	200	444.44	3,497.8	7.87	
	2300	0.78	30.3	46	1,394	210	269.23	1,787.2	6.64	
	2300	2.13	23.5	45	1,058	230	107.98	496.7	4.60	
	2300	2.68	10.6	41	435	100	37.31	162.3	4.35	
	0000	11.67	6.2	50	310	69	5.91	26.6	4.49	5.98
6/3-4	2200	37.12	8.9	60	534	100	2.69	14.4	5.34	
	2300	18.65	8.6	69	593	100	5.36	31.8	5.93	
	0000	19.52	–	–	43	4	0.20	2.2	10.75	7.34
6/4-5	2200	15.75	3.9	48	187	35	2.22	11.9	5.34	
	2200	4.55	19.0	49	931	104	22.86	204.6	8.95	
	2300	8.05	31.3	44	1,377	200	24.84	171.0	6.88	
	2300	2.72	30.7	52	1,596	200	73.53	586.8	7.98	
	2300	3.42	31.2	50	1,560	200	58.48	456.1	7.80	
	2300	4.03	32.8	54	1,771	200	49.63	439.4	8.86	
	2300	4.02	29.8	49	1,460	200	49.75	363.2	7.30	
	2300	3.68	31.5	45	1,418	200	54.35	385.3	7.09	
	0000	2.32	35.0	44	1,540	200	86.21	663.8	7.70	
	0000	2.32	31.8	49	1,558	200	86.21	671.6	7.79	
	0000	2.12	31.4	52	1,633	200	94.34	770.3	8.16	
	0000	3.15	27.0	54	1,458	200	63.49	462.9	7.29	
	0000	4.45	28.5	47	1,340	200	44.94	301.1	6.70	
	0000	3.48	33.8	49	1,656	200	57.47	475.9	8.28	7.58
6/5-6	2200	31.82	1.1	61	67	15	0.47	2.1	4.47	
	2300	26.62	1.7	61	104	14	0.52	3.9	7.43	
	0000	27.67	2.8	59	165	43	1.55	6.0	3.84	5.25

(continued)

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Table 5. Kvichak River sockeye salmon smolt photo-counter calibration data, index site, 1969 (cont.).

Date	Hours	Fishing time [1]	Weight [2]	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily average fish/count
6/10-11	2200	14.78	15.3	51	780	139	9.40	52.8	5.61	
	2200	13.63	11.6	57	661	113	8.29	48.5	5.85	
	2300	3.68	12.5	51	638	102	27.72	173.4	6.25	
	2300	2.13	13.7	53	726	118	55.40	340.8	6.15	
	2300	12.75	9.9	51	505	91	7.14	39.6	5.55	5.88

Seasonal Average   6.55

Length and Weight of Smolt by Age Group

Twenty-nine one-pound and four two-pound samples were taken through-out the season to determine length and weight by age group. The age class separation point was determined by aging scales from fish, which by length, bracketed the separation. The point was determined by reading all scales from the first age-weight-length sample taken. The age class separation point was 97 millimeters. Verification of point was continued throughout the season by reading scales from fish that, by length, bracketed the point on either side of five mm. Using this method, it was estimated that the 1969 smolt index catch consisted of 52.3 percent Age I smolt and 47.7 Age II smolt. Age I smolt aver-aged 92.5 millimeters in length and 5.7 grams in weight while Age II smolt aver-aged 109.3 millimeters and 10.6 grams. Table 6 and Figure 3 show weighted length frequencies of the smolt index catch.

DISCUSSION AND COMPARISON WITH PAST DATA

The 541,017 Age II smolt were progeny of the 1966 escapement of 3,775,000 adults and 594,327 Age I smolt were progeny of the 1967 adult escapement of 3,216,000.

Based on the cyclic nature of Kvichak River salmon production 1966 is the first brood year following a peak brood year to have fewer Age II smolt than Age I smolt. The Age II smolt production comprised 45 percent as compared to comparable brood years (1953, 1957, and 1961) average Age II production of 84 percent. The Age I smolt from 1966 are second largest when compared to these other brood years. The larger year was 1953 when Age I smolt averaged 89 milli-meters in length but only contributed 27 percent to the total brood year smolt production. The larger percentage of Age I smolt from the 1966 brood year was no doubt due to good growth conditions allowing the fingerlings to reach a size favorable to smoltification.

The total index for the 1966 brood year was 1,189,338 smolt (Age I = 648,321; Age II = 541,017). This is approximately one-half million less than the total index for brood year 1961 which had a total adult return of 3,578,000 or 2.07 return per smolt. The average return per smolt for comparable brood years (1953, 1957, and 1961) is 5.77 (Appendix A, Table 8). On the basis of this an expected return for 1966 could be in the order of 6,900,000.

However, since 1953 the trend has been a lower return per smolt for comparable brood years (Appendix A, Table 8). This lowering is in conjunction with increasing peak year escapement sizes for each succeeding peak year. Considering this it would seem more likely that the 1966 brood year return would

Table 6. Weighted length frequencies of sockeye salmon smolt, Kvichak River, index site, 1969.

Length (mm)	Frequency	Length (mm)	Frequency
69	210	98	11,126
73	32	99	8,857
77	111	100	4,227
79	367	101	2,155
80	215	102	4,877
81	1,213	103	7,565
82	4,828	104	11,720
83	8,073	105	19,944
84	14,608	106	27,525
85	30,212	107	30,772
86	26,664	108	48,510
87	33,244	109	31,960
88	48,389	110	41,336
89	62,857	111	42,636
90	84,344	112	41,507
91	67,935	113	33,695
92	63,164	114	35,036
93	57,990	115	35,828
94	47,373	116	18,922
95	27,215	117	27,564
96	8,992	118	19,020
97	6,291	119	7,642
		120	7,920
Age I smolt = 594,327		121	5,180
		122	5,270
Percent = 52.3		123	5,360
		124	1,323
Average length = 92.5		125	2,159
		126	1,214
Average weight= 5.7		127	167

Age II smolt = 541,017

Percent = 47.7

Average length = 109.3

Average weight = 10.6
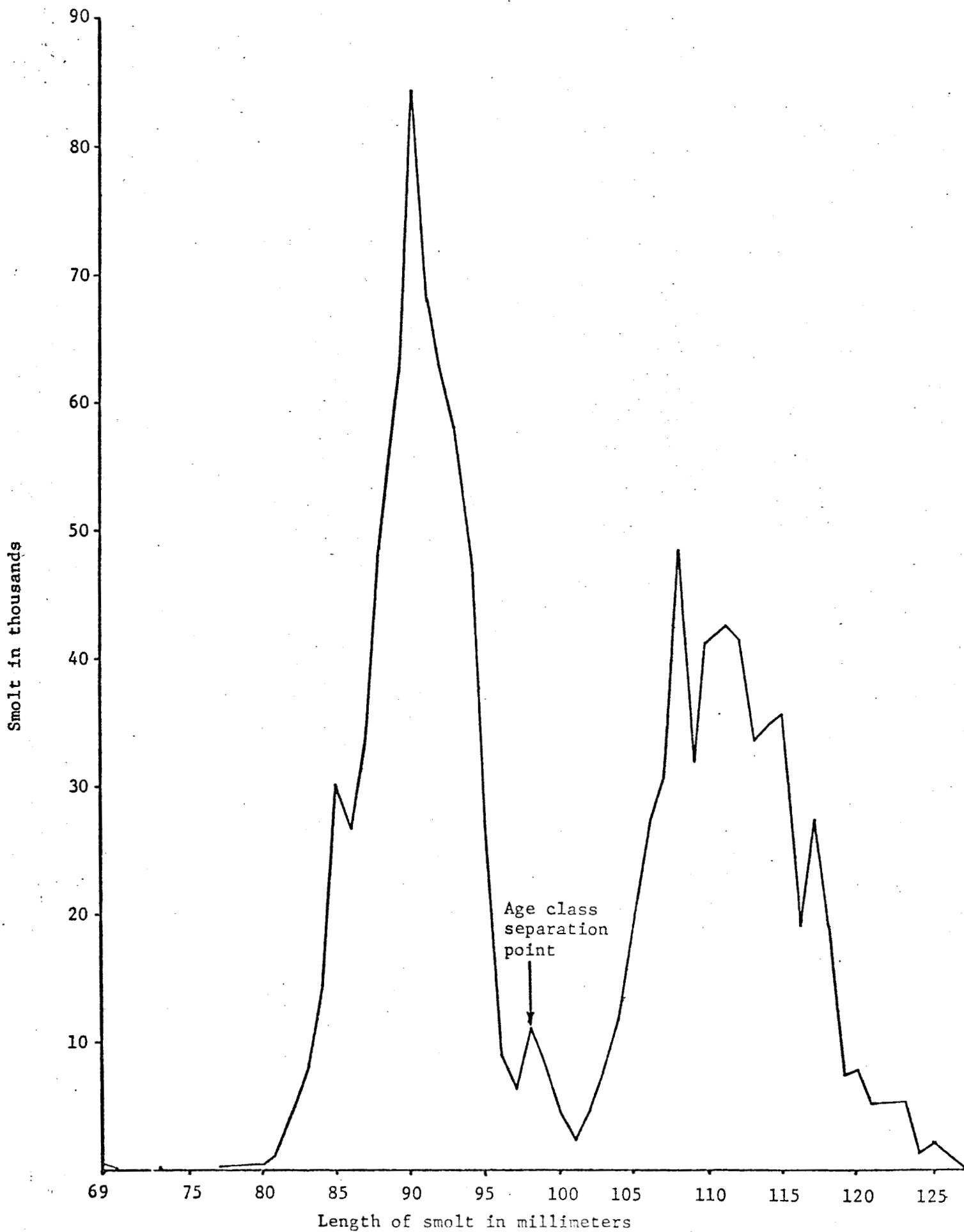
FIGURE 3. Weighted length frequencies of sockeye smolt in millimeters, Kvichak River, index site, 1969.

be closer to that which was experienced by the 1961 brood year. Using this return per smolt figure (2.07) a predicted return for 1966 would be in the neighborhood of 2,500,000. This would give a return per spawner figure of less than one (1) as was the case for 1961.

Considering return per smolt by age group for comparable years the same phenomenon of consistent lower return rates are again observed. For Age I smolt the return has declined from 7.55 (1953) to 4.46 (1961) with an average of 5.91. Returns for Age II smolt have been reduced from 9.68 to 1.91 (1961) with an average of 5.99. These reductions for both ages of smolt are in direct correlation with larger peak year fingerling holdover. This may increase intraspecific competition with the fry of the following year, possibly resulting in smolt of poorer condition. A near linear relationship is shown when peak cycle escapements are graphed against following year return per smolt by age group. Age II from 1966 show no return from this relationship while Age I show a return of approximately (based on a 21,000,000 1965 escapement) 1.0 per smolt (Figure 4).

The same types of relationship exists when peak cycle escapements are plotted against total return per smolt. This relationship however gives a zero return in peak year plus one for peak year escapements at or over 17.2 million (Figure 4).

Assuming that the previously mentioned relationship of peak year escapement to following brood year adult production from Age I smolt is valid and that the 1961 brood year adult return per Age II smolt is near the lower limits (this is the lowest on record of the project and not accepting graphed relationship of zero) the following brood year prediction would be:

$$648,321 \text{ (Age I) } \times 1.0 = 648,000$$
$$\text{and } 541,017 \text{ (Age II) } \times 1.9 = \underline{1,028,000}$$

Total 1966 brood year return = 1,676,000

This would give a return per spawner relationship of 0.44. The 1961 return per spawner is 0.96. The relationship between the returns for the two brood years is nearly the same as the relationship between two corresponding peak year escapements, i.e., the 1965 escapement is 1.66 times larger than the 1960 escapement and the predicted 1966 brood year return would be 2.18 times smaller than the 1961 return. This same relationship generally holds true for the other years concerned.

Using escapement-return data (Seibel, 1970) for non-peak years only an estimated adult return for 1966 is 7,737,000.

- 16 -
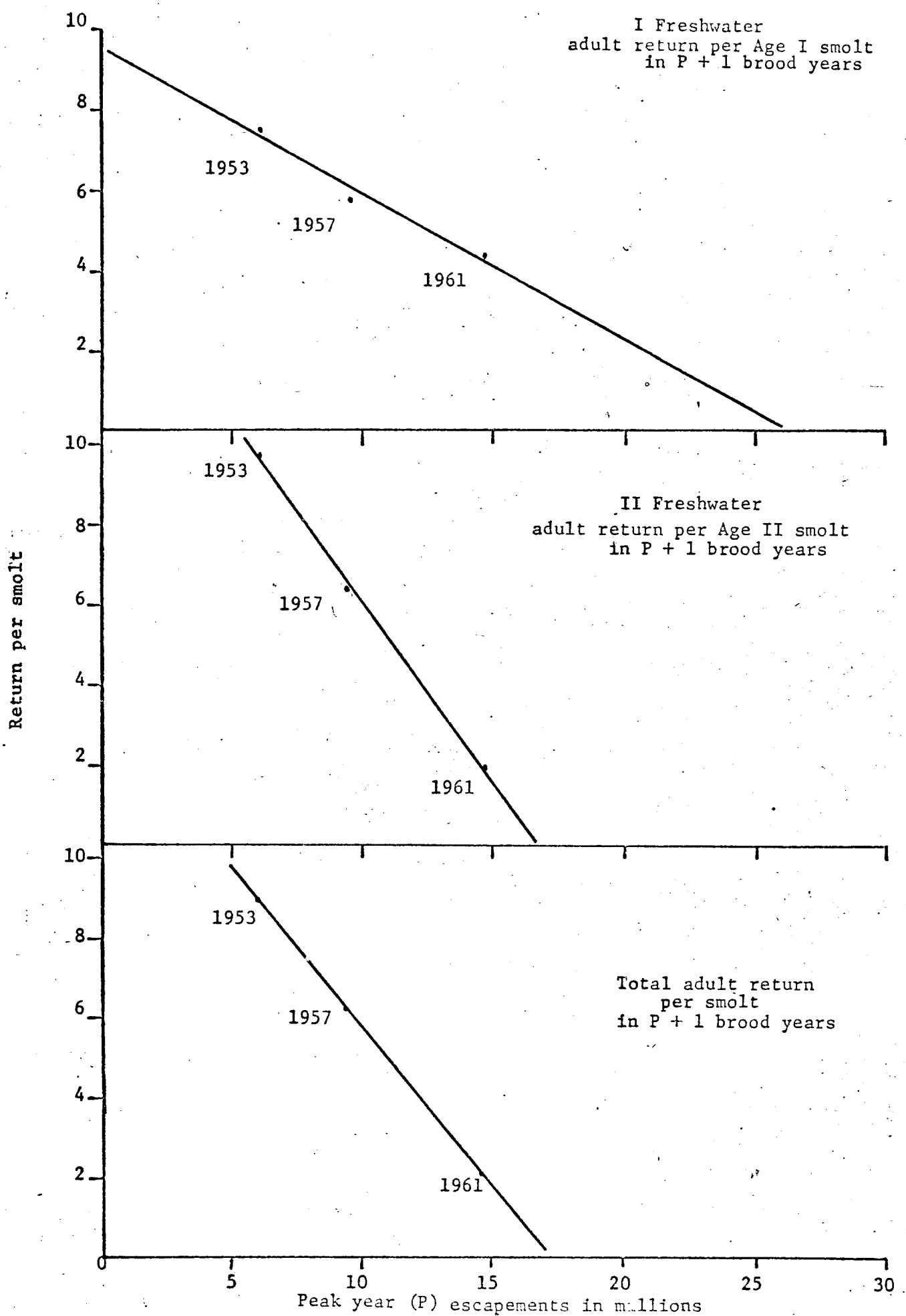
FIGURE 4. Comparison of peak brood year (P) escapements and corresponding adult returns per smolt, by age group and total, for brood years 1953, 1957, and 1961 (P + 1).

Brood year 1967 Age I smolt average length is the third largest recorded during the history of the project. Here the important implication may be that these large smolt were the product of a large escapement and also may mean that a high marine survival can be expected.

TOTAL SMOLT OUTMIGRATION ESTIMATE

In 1969 no total smolt outmigration estimate was attempted.

The total outmigration estimate portion of this project has proceeded through two phases. These were 1) volumetric which was based on estimates of smolt passage rate expressed in catch per volume of water versus flow and, 2) mark-recovery using forced air and fluorescent pigment to mark smolt. The recovery gear used over two years consisted of tow nets, mobile traps, and migrant dippers. For a variety of reasons none of the recovery gear was sufficient to conduct a reliable mark-recovery program.

The third phase of the program will be based on electronics and will utilize sonar to obtain a total outmigration estimate.

The equipment to be used is, at the time of this writing, ready for operation. A brief description of the equipment follows: The array for the sonar transducers is built so as to have every other transducer emitting its signal cone vertically toward the river surface while alternate transducers emit their signal cone downstream at an angle to the river surface. Figures 5 and 6 show the effect of this arrangement, that being a minimal area of space through which smolt may pass and not be registered by the sonar. The array is 22 feet in length and has 28 transducers. Counts will be displayed on a count pack that has two digital registers, one for each type of transducer. The capacity of each register is 18,000 unit counts per minute giving the counter a total capacity of 36,000 unit counts per minute. Intermediate between counter and array is electronic gear that will control the rate of signal impulses per minute and a range control. The signal rate control will allow this equipment to be used in a large range of water velocities while the range control will allow it to be operated in water depths to 12 feet. As of the time of this writing optimal minimum depth is five feet. This feature of a large depth range is especially desirable for the Kvichak River as it will allow the sonar to operate during the Iliamna Lake break-up when the river is frequently covered floe ice. In order to make sure ice floes are not being registered by the sonar an oscilloscope will be used to determine depth of the ice thus allowing operators to adjust range accordingly. The power supply needed for operations will be a 12-V car battery.

Horizontal
transducer
signal cone

Vertical transducer
signal cone

Water flow

Dead space

Dead space

Horizontal
transducer

Vertical
transducer

Sonar array

River bottom
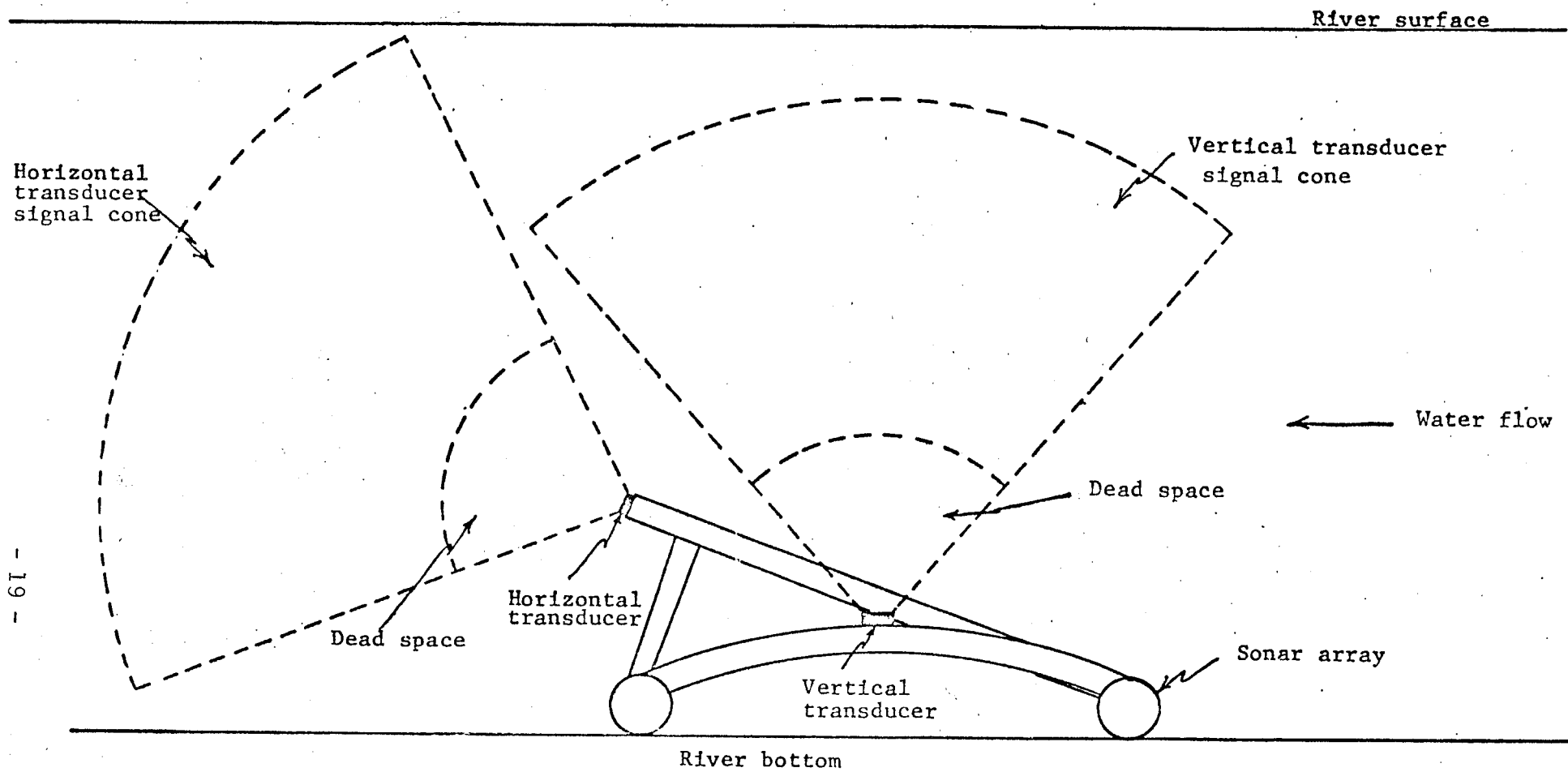
FIGURE 5. Schematic of the Bendix smolt counter sonar array, side view, drawing not to scale.
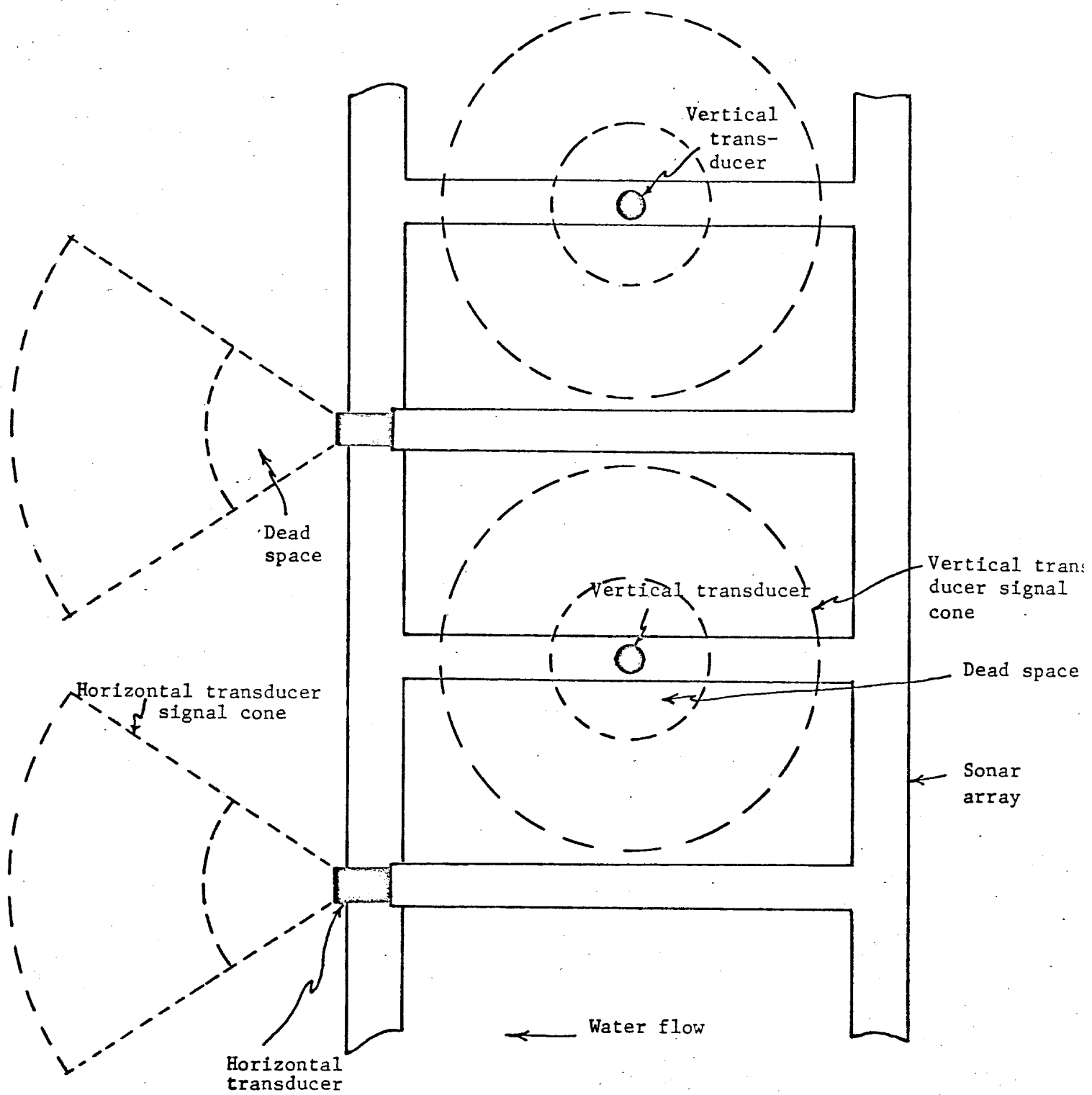
FIGURE 6. Schematic of the Bendix smolt counter sonar array, top view, drawing not on scale.

The sonar will provide a biomass estimate of the smolt outmigration. To convert this estimate into numbers the sonar must be calibrated. To accomplish this a metal fyke trap mounted on pontoons (to be described in the following section) equipped with photo-electric counters developed by the Fisheries Research Board of Canada will be stationed downstream of the sonar array. The procedure will be correlate numbers of fish caught by the trap to counts registered by the sonar.

INDEX EVALUATION

Toward the end of the 1968 smolt season differences in age composition and numbers were noted between the index site and Site 5 (Figure 1). On the basis of this it was decided to fish Site 5 again in 1969 in an attempt to further evaluate index net catches. In conjunction with this it was also decided to experiment with new equipment.

The new equipment was a metal fyke trap having the same dimensions, 4 feet x 4 feet, as a standard fyke net used on the index.

The wings of the trap had a 9 foot spread and were covered with 1/2 inch mesh galvanized hardware cloth. The trunk of the trap had 3/8 inch mesh hardware cloth.

The trunk of the trap was constructed to accomodate either photo-electric gear now in use on the project or the previously mentioned photo-electric counters developed by the Fisheries Research Board of Canada.

The trap was mounted between two pontoons using four stiff arms which were mounted on the pontoons themselves, and was raised and lowered using a winch. The cable was attached to the forward portion of the trap and ran through a pulley connected to an "A" frame support mounted on the front of the pontoons. The stiff arms acted as fulcrums causing the trap to describe a slight arc when being raised or lowered. In operation the trap could be lowered into the water within five seconds and raising in about 15 seconds.

Due to faulty electronic gear, high winds, and inadequacies of design on the wing cross-member supports which caused smolt avoidance, a complete season's catch was not obtained. However, the trap did fish continuously from May 28 to June 11. Catches are shown on Table 7. Table 8 and Figure 7 show weighted length frequencies for Site 5. Figure 8 compares daily catches for the two sites while Figure 9 compares weighted length frequency percentages. As can be seen from Figure 9, Site 5 caught more Age I smolt but fewer Age II smolt.

Table 7. Kvichak River sockeye salmon smolt expanded twenty-four hour Site 5 catch by period, 1969.

Date	1200-2200	2200-2300	2300-2400	0000-0100	Index total	0100-1200	Daily total	Accumulative total
5/28-29	–	3	90	280	373	308	681	681
29-30	21	86	220	153	459	513	993	1,674
30-31	318	0	734	3,617	4,351	4,720	9,389	11,063
31-6/1	1	686	5,199	33,255	39,140	49,068	88,209	99,272
1-2	0	1	2	2	5	5	10	99,282
2-3	2,888	640	580	610	1,830	2,214	6,932	106,214
3-4	36	1	4	1	6	836	878	107,092
4-5	1	3	144	2,214	2,361	21,424	23,786	130,878
5-6	3	106	2,100	2,059	4,265	3,530	7,798	138,676
6-7	179	89	89	290	468	157	804	139,480
7-8	3	81	81	81	243	96	342	139,822
8-9	10	1	12	5	18	35	63	139,885
9-10	98	12	29	39	80	105	383	140,168
10-11	6,583	2,317	680	3,475	6,472	367	13,422	153,590
Total	10,141	4,026	9,964	46,081	60,071	83,378	153,590	
Percent	6.60	6.70	16.59	76.71	39.11	54.29	100.00	

Table 8. Weighted length frequencies of sockeye salmon smolt, Kvichak River, Site 5, 1969.

Length (mm)	Frequency	Length (mm)	Frequency
77	252	98	1,222
79	6	99	438
80	20	100	825
81	524	101	683
82	321	102	1,032
83	852	103	1,494
84	2,789	104	2,156
85	5,452	105	4,136
86	5,084	106	4,177
87	9,827	107	2,632
88	12,697	108	2,257
89	11,184	109	2,481
90	16,581	110	7,926
91	12,111	111	3,133
92	8,706	112	2,684
93	6,236	113	2,498
94	4,253	114	1,816
95	4,038	115	3,270
96	1,669	116	726
97	320	117	1,226
		118	684
Age I smolt = 102,922		119	535
		120	950
Percent = 67.0		121	252
		123	706
Average length = 89.3		125	137
		126	182
		128	273
		131	137

Age II smolt   =   50,668

Percent   =   33.0

Average length   =   110.7
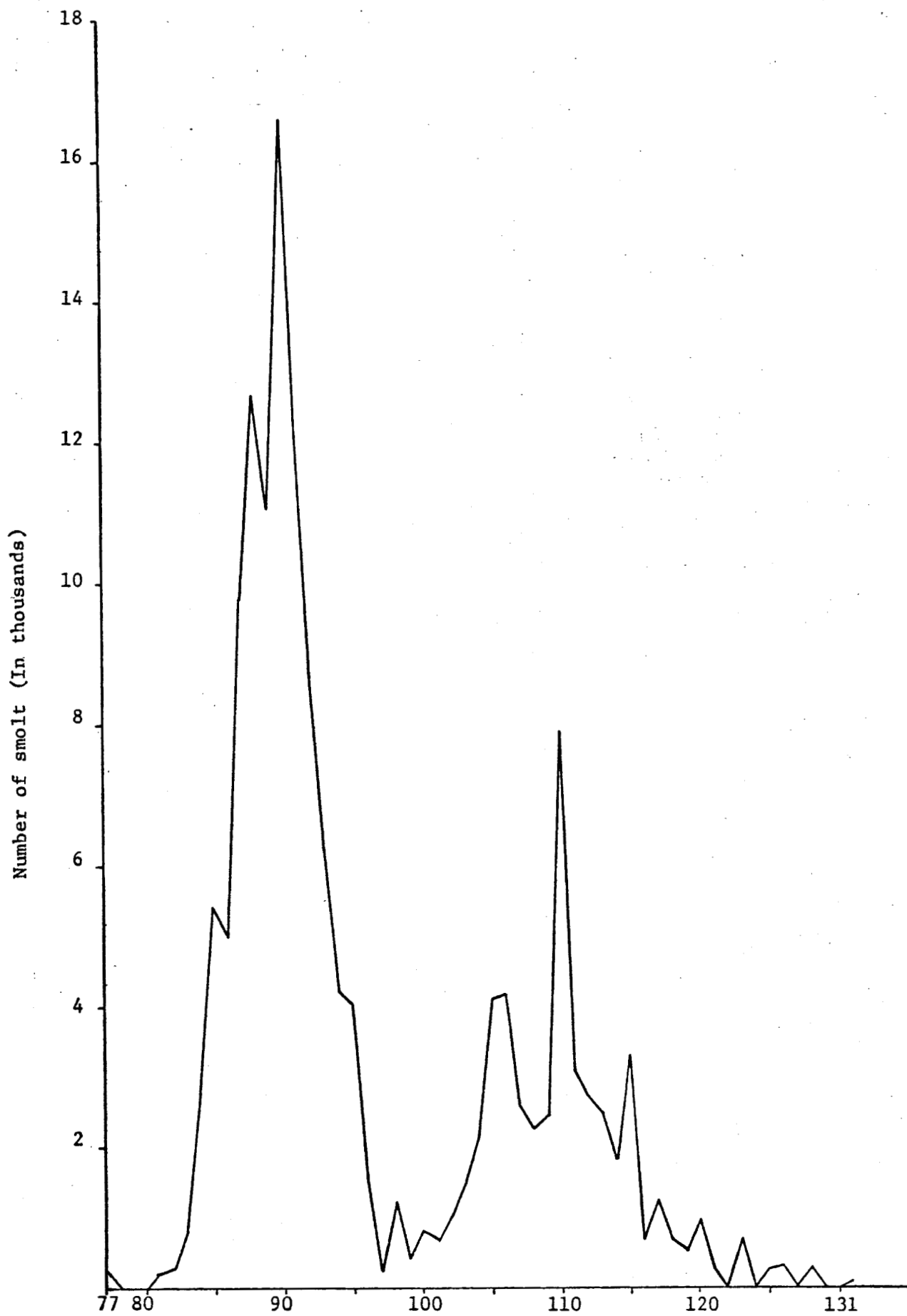
FIGURE 7. Weighted length frequencies of sockeye salmon smolt in millimeters, Kvichak River, Site 5, 1969.
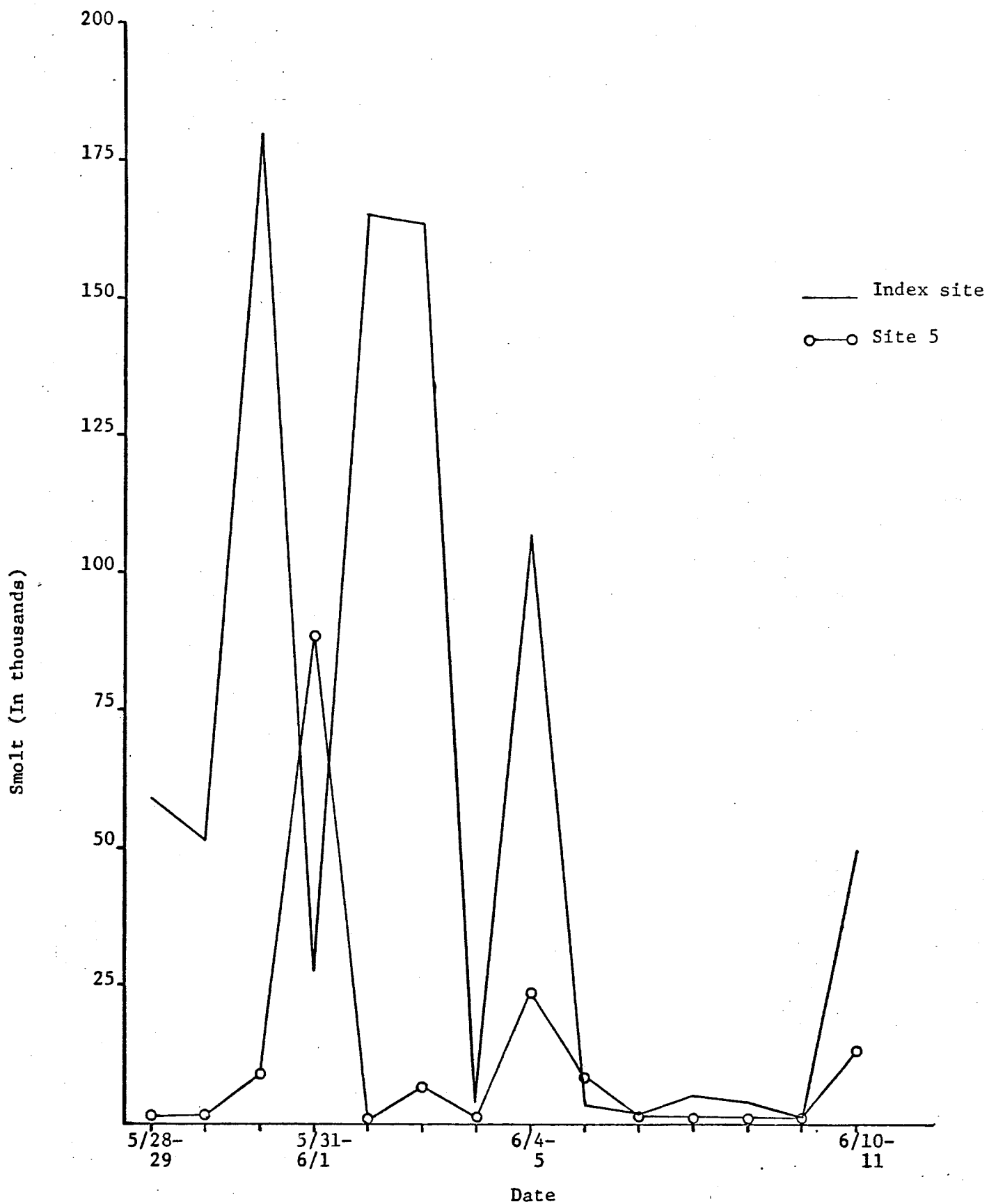
FIGURE 8 . Comparison of catches of sockeye salmon smolt, index site and Site 5, Kvichak River, 1969.
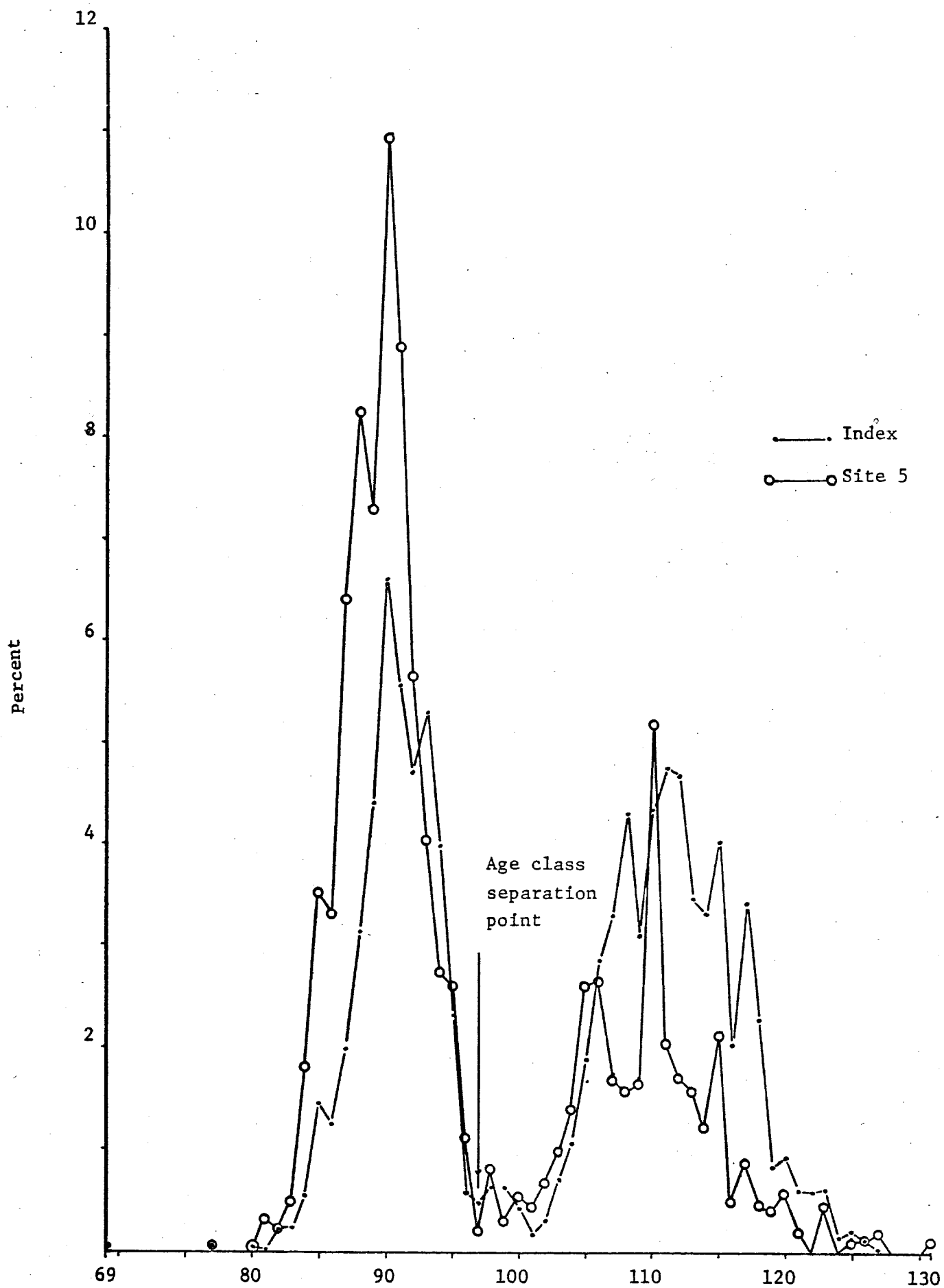
FIGURE 9. Comparison of percentages for weighted length frequencies of sockeye salmon smolt, index site and Site 5, Kvichak River, May 28-June 11, 1969

No correlation existed for daily catches, probably because of the extremely high winds encountered throughout the time period that was fished. These high winds made it very difficult to hold the equipment in place in the river. Due to avoidance and harsh operating conditions no true evaluation was obtained for 1969.

KVICHAK SMOLT DISTRIBUTION PILOT STUDY

In 1969 it was decided that a smolt distribution study should be undertaken on the Kvichak River. Distribution of smolt within a cross-section of stream obviously influences the practicality of fishing a single site such as the existing index location. Obviously if fish were oriented in the center of the velocity cross-section in a stream, and a net site was located near one edge of that cross-section, that site would be practically useless as a good indexing tool. The implications are also obvious relative to selection of random fishing station or set fishing stations on the cross-section of a stream such as the Kvichak River.

Equipment constructed for use on the Kvichak in 1969 was a very simple gill net array. The netting was 1/2 inch monofilament gill net. A vertical array of panels measuring 2 feet x 1-1/2 feet were arranged on 3/16 inch nylon lines. A space one foot wide was left between panels to prevent leading the fish vertically from one panel to another thereby catching them at a depth other than that which they were originally traveling (Figure 10). To place the net arrays in the river a 1/2 inch polyproplene line was stretched from one river bank to the other, tightened with a rope come-along, and individual net arrays spaced equidistant across the river channel. On the bottom of each gill net array was a steel 1-inch bar with two lead weights fastened on the ends. The lead weights varied in size from 3-5 pounds. The heaviest weights were used in the center of the river where stream velocity was greatest and weight was required to prevent the net array from trailing downstream. Since this method on smolt fishing had not been utilized on the Kvichak River previously, the 1969 program was largely developmental on gear and on fishing techniques.

In selecting fishing sites the river was observed for velocity and cross-section of channel in an area to one of our regular fishing sites including both the standard index site and auxillary site in Kaskanak Flats (Figure 11). A site was chosen in each case where velocity was not so severe as to make gill net fishing impossible.

Once a site was selected a Danforth anchor was placed in each bank where trees were not available. The polyproplene rope, wound on a spool in

Figure 10. Schematic diagram of smolt gill net arrays
used in Kvichak River smolt distribution study,
May-June 1969.

Snaps · Shore-to-shore line

Net roller bar

Water surface

½" mesh monofilament gill net

¼" steel spreader bar

3/16" nylon line

1.5'

2.0'

1' space between panels

Lead anchor

Bottom

Lake Iliamna

3   2

1

1. Index site
2. Distribution site below index
3. Distribution site in Kaskanak Flats
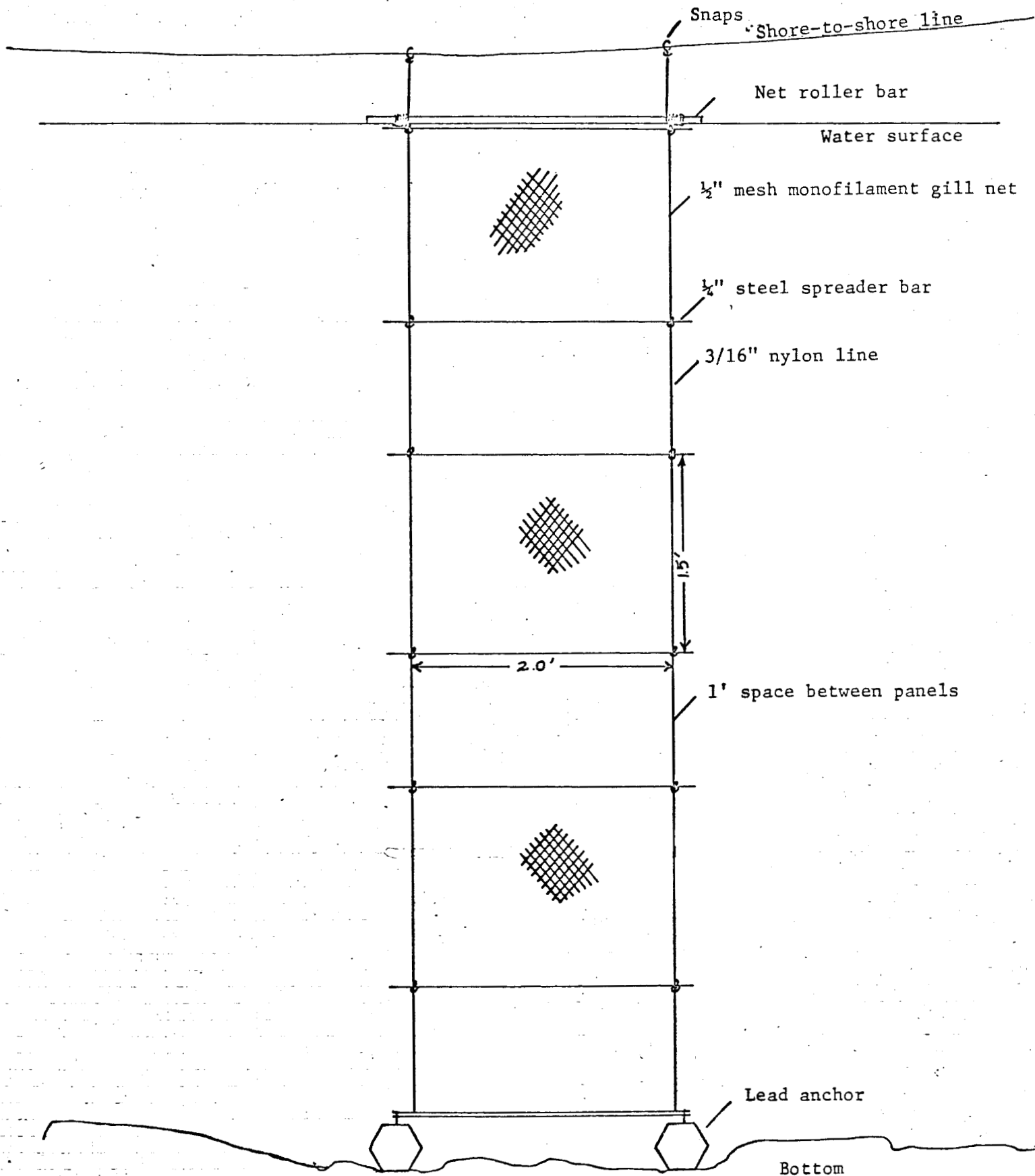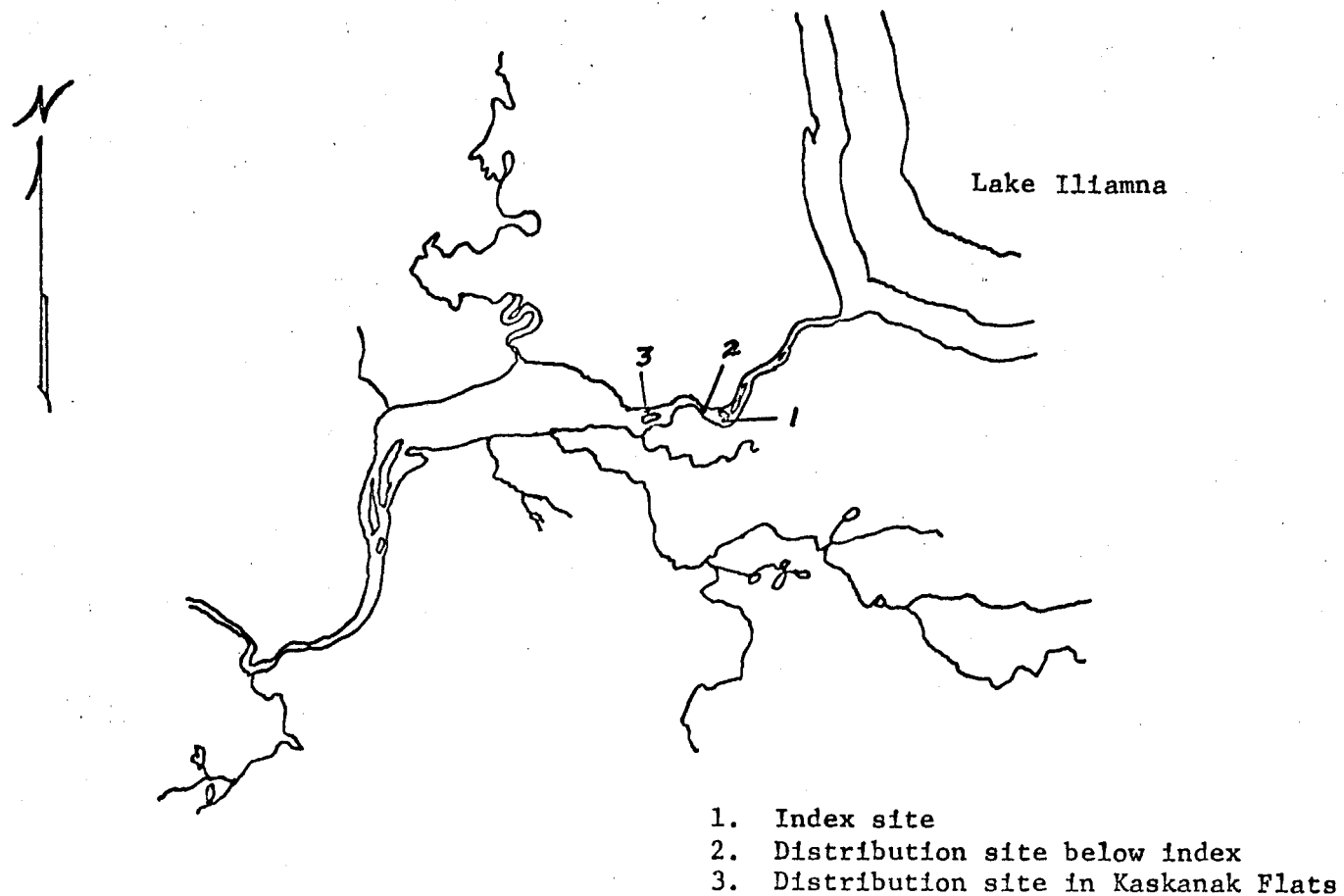
Figure 11. Kvichak River smolt distribution sites and index site.

a skiff, was tied to one anchor and run upstream to a distance that would span the river. The skiff was then turned downstream to the other anchor point and the line tied there as soon as it was straight across the river on the downward drift. A rope come-along was then hooked to the anchor and to the rope spanning the river, and tightened until the rope stood free of the water for the full width of the river. The rope was marked with tape flags at 10 foot intervals with the measurement inscribed on the tape. After stretching the rope and estimating the total river width the channel was divided into equal parts relative to the number of net arrays that were available. That is, if the river was 600 feet wide and we had five arrays we would start 50 feet from one shore to place the first station with the following nets placed at 100 foot intervals to within 50 feet of the opposite shore.

The actual fishing was accomplished by loading all nets, which were rolled upon the top spreader bar, into the boat and traveling from site to site across the river, recording the time of each net installation. To install a net each end of the top spreader bar was held by a man, lifted over the side of the boat, with the weights on the bottom bar unrolling the net from the top spreader bar until the anchors struck bottom. An elastic tie down strap was hooked across the remaining net on the upper bar to prevent it from unrolling further. The upper bar was then snapped to the cross river line with spring loaded steel clips. Time of the installation thus recorded the other sites were installed in order.

To retrieve nets the skiff would return to the first net installed, the time would be recorded, then two people would turn the net in line with the current and pull the net rapidly into the skiff. Each net had a special slot in a net box to prevent fish from falling out and being mixed with other net catches. The catches were taken to a tent and measured to describe the catch of the few sets which were successful.

Throughout the course of the season very few fish were actually captured with the equipment. It seemed apparent that the cause of the small catch was primarily the small number of fish involved in the outmigration, and the small area of the river which was actually covered by nets. Net panels which were hung in trammel fashion, that is with one panel directly behind the other, did seem to catch both sizes of fish available in the run. Although the technique requires three men nearly full time during the fishing hours it does appear that the method is applicable to smolt distribution and work will be continued in the future on a time available basis.

It is common knowledge that within the cross-section of a straight river channel the area of maximum velocity will be generally oriented over the deepest portion of that cross-section. In both sites fished all smolt caught were in the area of approximate maximum velocity. Because catches were so small, a con-

siderably larger sample will have to be taken before conclusion can be drawn from this type of program. See Figures 12 and 13 for catch information by site by station.

SUMMARY

1. The index procedures were the same as in past years. Twenty-four hour sampling was initiated on May 24 and terminated on June 18. A total of 101 hours of fishing was lost to ice, algae, high winds, and detritus.

2. Water temperatures ranged from 32.5^O to 46° F., with a mean seasonal average of 41° F. The water temperature at the beginning of the outmigration was 38° F. The temperature at the peak of the outmigration was 34° F., a reading 2^O lower than any previously recorded.

3. The 1969 expanded twenty-four hour index catch was 1,135,344. The major peaks occurred on May 30-31 and June 1-3. These peaks accounted for 45 percent of the index catch. The index hours (2200-0100) catch was 543,351 or 47.86 percent of the total catch.

4. Fishing with photo-electric counters was initiated on May 31 and terminated on June 12. Daily smolt per photo-electric count ratios ranged from 5.25 to 7.66. The seasonal average was 6.55.

5. Twenty-nine one-pound and four two-pound samples were taken during the season to determine length and weight by smolt age group. The age class separation point was 97 millimeters. Age I smolt averaged 92.5 mm and 5.7 grams while Age II smolt averaged 109.3 mm and 10.6 grams.

6. The 1969 smolt index catch consisted of 52.3 percent (594,327) Age I smolt and 47.7 (541,017) Age II smolt. The Age I smolt were the product of the 1967 brood year escapement of 3,216,000 and the Age II smolt were the product of the 1966 brood year escapement of 3,775,000.

7. 1966 is the first brood year following a peak cycle year to have fewer Age II smolt than Age I smolt. Age II smolt were only 45 percent of the total brood year production as compared to an average of 84 percent for comparable brood years (1953, 1957, and 1961). The 1966 Age I smolt are the second largest when compared to these years.

8. In 1969 no total smolt outmigration estimate was attempted.

9. In 1970 sonar will be used to obtain a basis for an outmigration estimate.

Figure 12. Kvichak smolt distribution study May–June 1969, smolt catches by length by station.

Station

Total channel width – 225'
Diagrammed facing upstream
Scale 1" = 25'

x – Replicate 1, 5/30
o – Replicate 2, 5/30
– – Replicate 1, 5/31
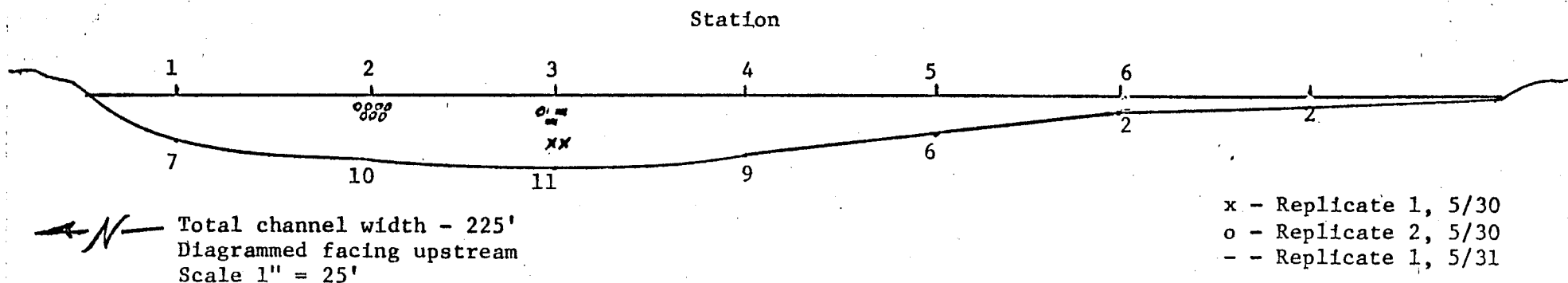
Site 5, Kaskanak Flats, Kvichak River May 30-31

Date	Replicate	Station	Period Fished	T. Depth (ft)	Distance from N. bank (ft.)	Panel Depth (feet)	Catch	Catch lengths in mm, snout-fork
5/30	1	3	2225–2332	11	75	6.0 – 7.5	2	110, 120
5/31	2	2	0002–0135	10	45	1.5 – 3.0	7	90, 90, 110, 113, 113, 117, 119 (?)
		3	0005–0137	11	75	1.5 – 3.0	1	115
5/31	3	3	––	11	75	3.0 – 4.5	$\frac{2}{12}$	––

Only panels catching smolt are reported.

Figure 13. Smolt distribution catches by length by station.

Station

1 1a   2   2a   3   3a   4 4a   5, 5a

10.5   ·12.5   13.0   13.8 14.5   18.0 15.5   13.0 12.2

Depth feet

Total channel width = 360'
Diagrammed facing upstream
Scale 1" = 50'

. - Replicate 1
x - Replicate 3
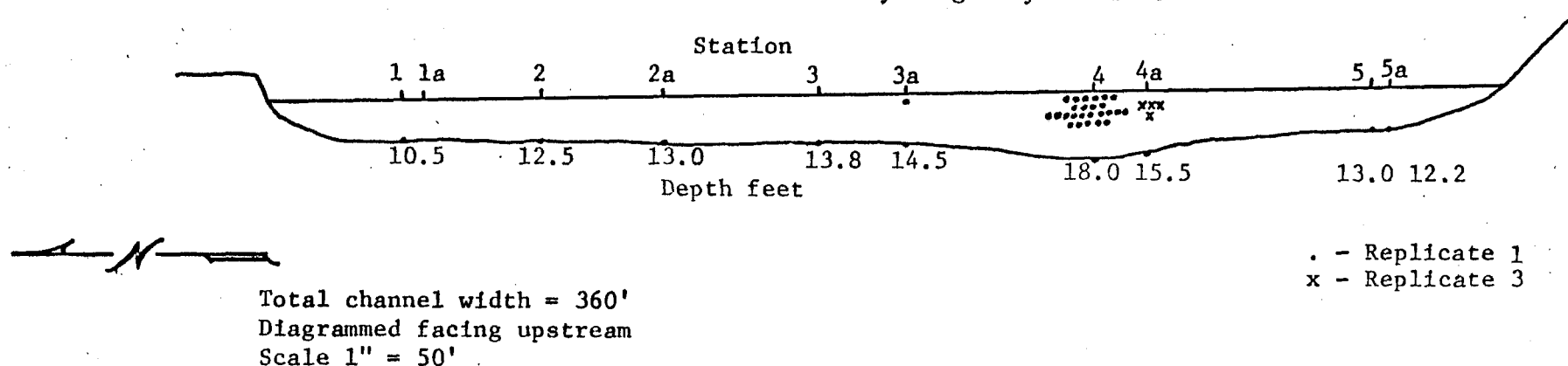
Site below index area, Kvichak River, June 1-7·

Date	Replicate	Station	Period Fished	T. depth (feet)	Dist. from N. bank (feet)	Panel depth (feet)	Catch	Catch lengths in mm
6/1-2	1	4	2328-0115	18.0	240	0.4 -1.9	6	86, 98, 88, 89, 91, 102
	1	4	2328-0115	18.0	240	2.9 -4.4	4	88, 93, 105, 113
	1	4	2328-0115	18.0	240	5.4 -6.9	10	116, 109, 93, 84, 84, 105, 94, 109, 101, 85
	1	4	2328-0115	18.0	240	7.9 -9.4	5	120, 86, 93, 105, 82 (+ 1 stickleback)
	1	3	2335-0130	13.8	160	0.0 -1.5	1	113
6/2	2	all	1508-1714	-	-	-	0	
6/2-3	3	4a	2240-0041	15.5	255	2.5 -4.0	3	87, 85, 108
	3	4a	2242-0047			5.0 -6.5	1	91
6/3-4	4	all(7)*	2157-0107	-	-	-	0	
6/5-6	5	all	2205-0227	-	-	-	0	
6/6-7	6	all	2212-0218	-	-	-	0	

On June 3 two new arrays were added, with station 1 set 30' from N. shore, others spaced 50' apart.

10. An index evaluation was attempted by fishing a metal fyke trap at Site 5. Due to faulty electronic gear, inadequacies in gear design, and extremely high winds an evaluation could not be obtained.

11. A smolt distribution pilot study was conducted using 1/2 inch monofilament gill netting mounted on vertical panel arrays measuring 2 feet x 1-1/2 feet on 3/16 inch nylon lines. Catches were too small to draw any definite conclusions.

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1969 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES

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ABSTRACT

The sockeye salmon (Oncorhynchus nerka) smolt enumeration and sampling program at the outlet of Lower Ugashik Lake was conducted from May 23 to June 6. A series of standard winged fyke nets were used to trap the smolt during their seaward migration. Five fishing sites, fished on a random schedule two out of every three nights between 9:00 p.m. and 2:00 a.m., yielded a total outmigration estimate of 5,048,673, consisting of 59.7 percent Age I and 40.3 percent Age II smolt.

The index net (site 4) was fished for a 3-hour period every night between 10:00 p.m. and 1:00 a.m. and for 24 hours every third day. Index fishing was used to obtain age, weight and length data from smolt and 24-hour sampling was used to determine the percentage of smolt migrating to sea outside of the random fishing hours.

Freshwater and marine survival data for the Ugashik system are included.

INTRODUCTION

The Ugashik sockeye salmon smolt enumeration and sampling program was initiated in 1956 and has been operated every year since then with the exception of 1966. Data obtained from this program have been used to estimate relative abundance and age composition, and to determine average lengths and weights for each age class of sockeye salmon smolt migrating to sea. These data are used to estimate optimum escapement ranges and to forecast age composition of returning adults.

Field work was under the supervision of the author and Donald L. Siedelman, Assistant Area Management Biologist, who assisted with program

design. Participants were Michael Saylor and Monty Smith.

METHODS AND PROCEDURES

Ugashik River smolt program designs, fyke netting procedure and methods for collection of field data are discussed in Nelson (1965). Modifications of the program design and sampling procedures are discussed in McCurdy (1969).

Fyke net operations were conducted between May 23 and June 6. The smolt season was shortened by a late ice breakup, which occurred between May 18-21 and fishing was disrupted by severe weather conditions that prevailed between June 4-12. Drastic changes in river bottom contour (Figure 1) and excess debris in the river caused the program to be terminated on June 6.

RESULTS

The total smolt catch during index fishing hours at site 4 was 63,999 or 21.25 index points (Table 1). This is the smallest catch and number of index points on record (Appendix Table B-1).

Index net catches between 10 p.m. and 1 a.m. indicated only one outmigration peak (Figure 2). However, 24-hour sampling indicated a second peak on June 4, between 12 noon and 10 p.m. (Table 2 and Figure 2).

The random scheme was fished 10 days of the 15-day season, and caught a total of 32,598 smolt (Table 3). Site 3 caught the majority of smolt. Sites 3 and 4 combined caught over 85 percent of the total random catch (Table 3).

Twenty-four hour sampling, conducted on four days of the 15-day season, indicated that 33.9 percent of the smolt outmigration occurred during the random fishing hours of 9 p.m. to 2 a.m. (Table 2).

The total estimated smolt outmigration for 1969 derived by methods described in Nelson (1965) was 5,048,673.

Smolt samples were separated into two fishing periods (Table 4). Size composition was determined from measurements of 567 smolt, while age composition was determined from readings of 280 smolt scales (Table 4). The percentage, mean length and weight of each age group were determined
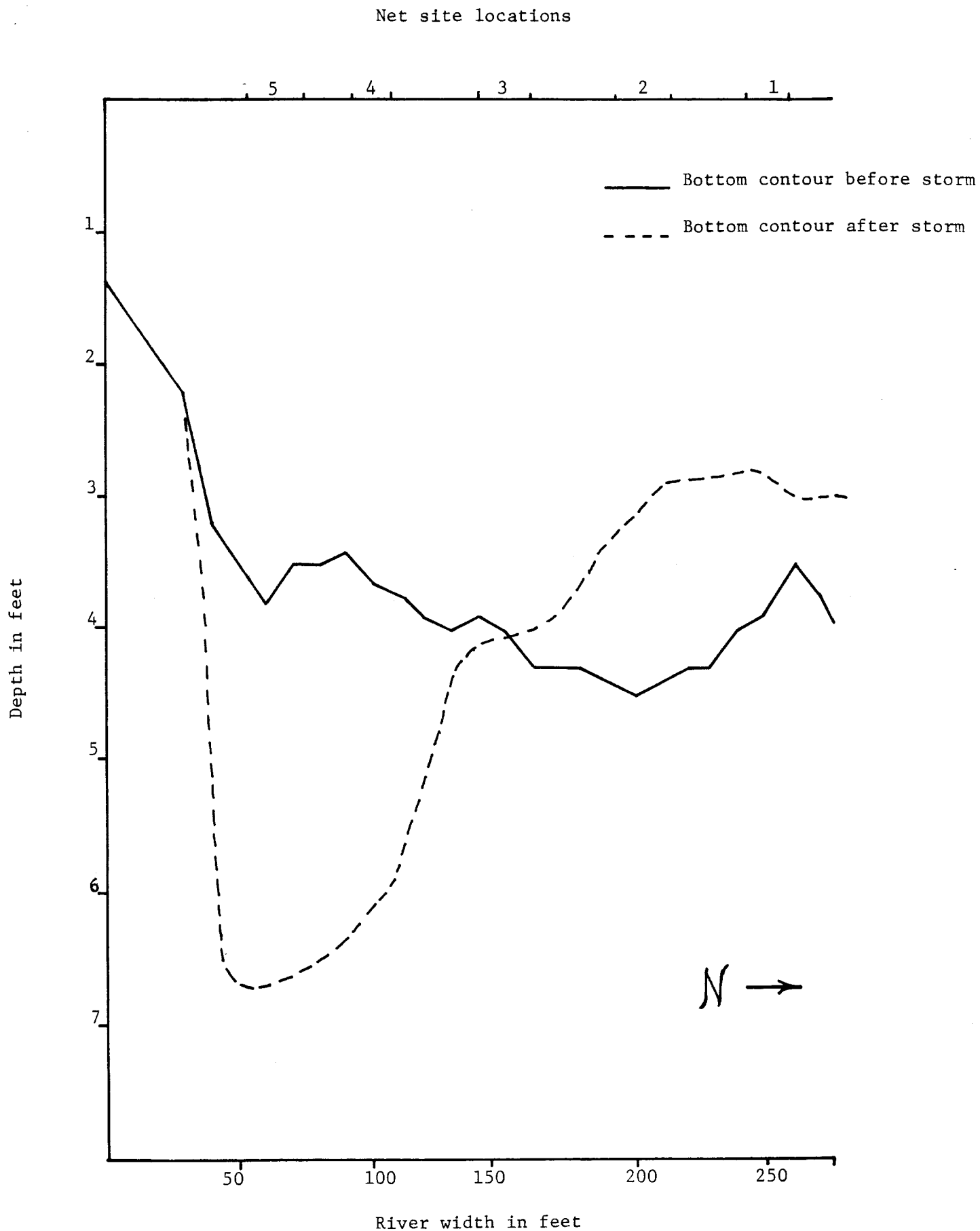
Figure 1. River bottom contour looking downstream before and after storm, depths taken at five foot intervals, Ugashik River, 1969.

TABLE 1. Ugashik River sockeye salmon smolt catch in index net by hour and day, 1969.

Date	Index hours			Total index catch		Index points[1]	
	2200-2300	2300-2400	2400-0100	Daily	Cumulative	Daily	Cumulative
May 23	359	460	206	1,025	1,025	0.34	0.34
24	351	1,196	1,853	3,400	4,425	1.13	1.47
25	386	951	995	2,332	6,757	0.77	2.24
26	338	617	575	1,530	8,287	0.51	2.75
27	1,756	1,471	957	4,204	12,471	1.40	4.15
28	3,761	709	437	4,907	17,378	1.63	5.78
29	2,844	742	557	4,143	21,521	1.38	7.16
30	19,568	8,111	1,426	29,105	50,626	9.66	16.82
31	37	97	77	211	50,837	0.07	16.89
June 1	176	414	94	684	51,521	0.22	17.11
2	64	559	619	1,242	52,763	0.41	17.52
3	802	984	1,064	2,850	55,613	0.95	18.47
4	283	153*	113*	549	56,162	0.18	18.65
5	1,066	3,224	1,039	5,329	61,491	1.77	20.42
6	585	1,454*	469*	2,508	63,999	0.83	21.25
Total	32,376	21,142	10,481	63,999	63,999	21.25	21.25
Percent	50.59	33.03	16.38	100.00	–	–	–

1/ One index point = 3,012.32 smolt.
* Interpolated data.
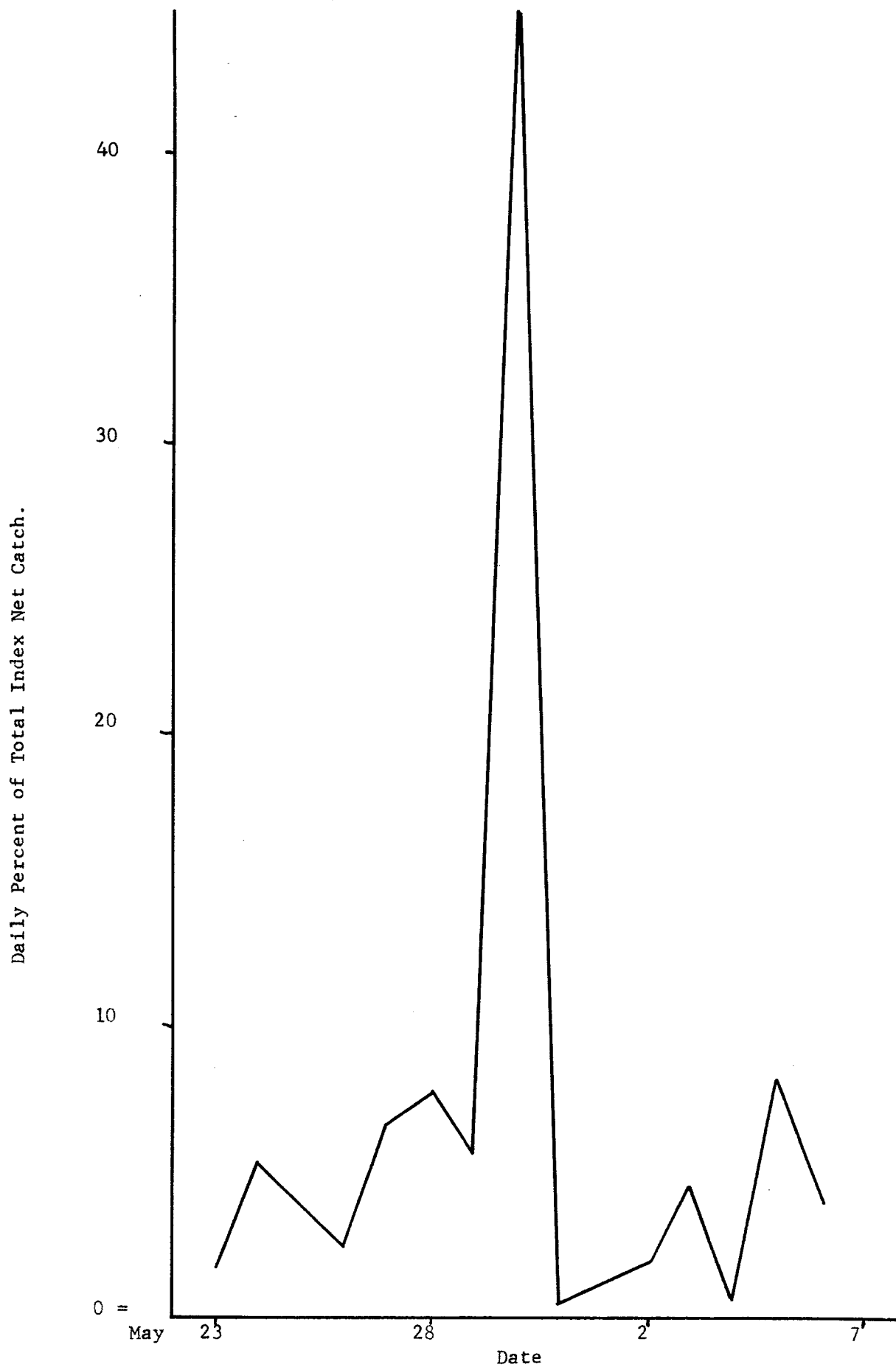
Figure 2. Daily index net catches of sockeye salmon smolt in percent of total index net catch, Ugashik River, 1969

TABLE 2. Ugashik River sockeye salmon smolt catches in index net during 24-hour fishing periods, 1969.

Time period	Date				Total	Percent
	May 25-26	May 28-29	May 31-June 1	June 3-4		
2200-2300	386	3,761	37	802	4,986	10.2
2300-2400	951	709	97	984	2,741	5.6
2400-0100	995	437	77	1,064	2,573	5.2
0100-0200	1,088	783	23	625	2,519	5.1
0200-0330	876	1,514	5	141	2,536	5.2
0330-0500	22	10	1	15	48	0.1
0500-0630	4	0	0	2	6	0.0
0630-0800	2	13	0	5	20	0.0
0800-0930	3	323	0	2	328	0.7
0930-1100	0	21	0	0	21	0.0
1100-1230	1,528	1	0	265	1,794	3.8
1230-1400	3,250	0	0	2,499	5,749	11.7
1400-1530	0	5	0	2,466	2,471	5.0
1530-1700	1,719	1	0	3,600	5,320	10.8
1700-1830	4	0	0	801	805	1.6
1830-2000	0	266	0	5,616	5,882	12.0
2000-2100	3	143	1	6,038	7,473	15.2
2100-2200	8	2,964	9	847	3,828	7.8
Totals	10,839	12,239	250	25,772	49,100	100.0

TABLE 3.   Ugashik River sockeye salmon smolt catches in the random sampling scheme by
fishing site, 1969.

| Date | Random sampling sites | | | | | Daily accum. |
	1	2	3	4	5	
May 24	11	115*	600	1,196	9	1,931
26	10	1,146	5,137	8	50	6,351
27	0	0	26	1,119	649	1,794
28	0	1	1,031	3,761	465	5,258
30	57	4	3,977	1,462	1	5,465
31	37	52	23	15	18	145
June 2	19	80	1,903	64	403	2,469
3	13	569	5,136	984	193	6,895
5	0	0*	30*	1,309*	759	2,098
6	49*	69*	30*	20	24*	192
Total	196	2,036	17,893	9,902	2,571	32,598
Percent	.61	6.25	54.89	30.38	7.87	100.00

*   Interpolated data.

TABLE 4. Ugashik River sockeye salmon smolt sampling data, 1969.

Period no.	Date	Index smolt catch	% of season total	No. of 1 lb. samples measured	No. of fish measured	No. of scales read
1	May 23–28	17,378	27.2	6	232	120
2	May 29–June 6	46,621	72.8	6	335	160
Totals		63,999	100.0	12	567	280

TABLE 5. Age, length and weight of sockeye salmon smolt by sampling period from the Ugashik River system, 1969.

Period no.	Date	Mean length in mm. of age group		Mean weight in grams of age group		Percentage of age group	
		I	II	I	II	I	II
1	May 23–28	98.7	121.2	7.7	14.7	47.8	52.2
2	May 29–June 6	96.2	121.2	7.4	14.3	70.2	29.8
Season weighted totals		97.4	121.2	7.5	14.5	59.7	40.3

Note: Age groups I and II denote number of winters in freshwater. Season total weighted by index catch.

by period and for the entire season by weighting the total number of samples for each period by the total catch for each period (Table 5).

Age I smolt comprised 59.7 percent of the total outmigration and averaged 97.4 mm in length and 7.5 grams in weight. Age II smolt comprised 40.3 percent and averaged 121.2 mm and 14.4 grams (Table 5).

DISCUSSION

Past catches in net sites 1 and 2 have averaged approximately 17 percent of the total random fishing scheme catch. This average percent is due mainly to large outmigrations and strong west winds which tend to force the smolt over to sites 1 and 2. Consequently, catches this year were practically non-existent in sites 1 and 2 and resulted in over 93 percent of the random catches being made in sites 3, 4 and 5 (Table 3).

The extremely small percentage of smolt (33.9 percent) caught during the random fishing hours was a result of a large outmigration of 21,000 smolt on June 4 between 12:00 noon and 9:00 p.m. (Table 2). Storm conditions consisting of a 20-30 mph east wind began on the morning of June 4 and is thought to have prematurely initiated the outmigration.

The storm persisted from June 4-12 and considerably changed the river mouth and channel (Figure 1). The river bottom, normally 3 to 4 feet deep in sites 4 and 5, was gouged out an additional 3 feet during the storm. Considerable filling occurred along the east bank of the river and created a large backwater area ten yards in front of net sites 1 and 2. It is very possible that these changes will have a direct effect on the smolt program in 1970.

SUMMARY

1. Total index smolt catch was 63,999 and was equal to 21.25 index points.

2. The random fishing scheme caught 32,595 smolt with sites 3 and 4 catching over 85 percent of the total random catch.

3. Twenty-four hour sampling indicated that 33.9 percent of the smolt outmigration occurred during random fishing hours.

4. Total smolt outmigration estimate was 5,048,673.

5. Age I smolt comprised 59.7 percent of the total outmigration and averaged 97.4 mm in length and 7.5 grams in weight.

6. Age II smolt comprised 40.3 percent of the outmigration and averaged 121.2 mm in length and 14.4 grams in weight.

7. The deep channel gouged out by a severe storm in early June may have a direct effect on the random sampling scheme in 1970.

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1969 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

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ABSTRACT

The 1969 season was the fourteenth year for estimating the outmigration of sockeye salmon smolt from the Naknek River lake system. Smolt were captured with standard winged fyke nets during their seaward migration. Six fishing sites were used in the fishing schedule.

Random and index fishing commenced on May 24 and was terminated July 16. Peak outmigration was between June 4 and June 22. Forty smolt were collected each sampling day for determining age, weight and length. Average Age I and Age II weights and lengths were comparable to the 13-year average. The 1969 Naknek River outmigration estimate was 11,546,017.

Analysis of smolt per spawner, smolt production and escapement-return data indicates the optimum adult escapement for the Naknek River is approximately 800,000 with a range of 700,000 to 1,000,000.

INTRODUCTION

The Naknek River sockeye salmon smolt sampling program, initiated by the Bureau of Commercial Fisheries in 1955, was continued in 1969. This was the fourteenth season of sampling smolt in the Naknek River. Sampling covers thirteen brood years having adult escapements ranging between 278,118 to 2,231,807. Sampling methods have remained unchanged since the Alaska Department of Fish and Game assumed responsibility of this project in 1966.

Field supervision was by the author, with Glen Van Valin aiding in the initial program operations. Field work and data collection was accomplished by crewleader, Gerald R. Craig and assistant, Robert W. Manning.

METHODS AND PROCEDURES

Smolt were captured in fyke nets suspended from a 1/2-inch wire cable stretched across the Naknek River approximately 26 miles above the river's mouth. Due to varying water depths and rising water conditions, nets varied (between 4 to 7 feet) in depth with a standard width of 4 feet. Six sites were randomly fished for 90 minutes between 0900 and 0600, two of every three nights. On the second night, an index net (Site no. 4) was fished 24-hours. Index fishing was not conducted during the third day.

Smolt were fished with a live box attached to the index net during the 24-hour fishing periods.

Smolting commenced May 24 and terminated July 16. Forty smolt were collected each night to determine age, weight and length. Hydrological and weather data were recorded.

RESULTS

Weather

Smolting was not conducted June 14 and 15 due to high winds. During this period, a deadman broke causing the net cable to slip. This was corrected and fishing continued June 16, after the wind abated.

Based on past weather observations made by Jaenicke (unpublished), the major portion of smolt outmigration occurs between water temperatures of 51° F. and 55° F. This season the peak outmigration occurred when water temperatures were between 48° F. and 53° F. Water temperature during the day of outmigration, June 9, was 48° F. (Table 1).

Random Catch

Random sampling commenced May 29 and terminated July 16. Peak outmigration occurred between June 4 and June 22, when 76.45 percent of the seasons smolt catch occurred (Table 2). Determination of the peak period was based on daily catches of 5 percent or more of the total season's catch. Timing of peak period catches is comparable with past years for both index and random sampling.

The total random catch was 119,965 smolt. A peak catch of 26,456 smolt, 22.05 percent of the total smolt catch, occurred June 9 (Figure 1).

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TABLE 1. Mean water temperature by day, Naknek River, 1969.[1]

Date	Mean Water Temp. °F	Date	Mean Water Temp. °F
May 27	44°	June 22	53°
28	45°	23	50°
29	48°	24	51°
30	49°	25	51°
31	49°	26	52°
		27	54°
June 1	50°	28	54°
2	49°		
3	48°	29	54°
4	50°	30	53°
5	48°	July 1	55°
6	48°	2	57°
7	*	3	56°
		4	54°
8	50°	5	56°
9	48°		
10	49°	6	55°
11	50°	7	55°
12	49°	8	56°
13	50°	9	56°
14	50°	10	57°
		11	57°
15	*	12	56°
16	52°		
17	51°	13	53°
18	*	14	55°
19	*	15	54°
20	50°	16	54°
21	52°		

1/   Water temperatures were recorded six times daily.
*   No temperatures recorded.

TABLE 2. Naknek River random sampling catches of sockeye salmon smolt by fishing site. 1969.

Date	Sites						Total	Percent of daily total
	1	2	3	4	5	6		
May 29	33	1,061	222	44	186	522	2,068	1.72
30	328	0	2,535	14	664	48	3,589	2.99
June 1	31	304	529	486	880	1,176	3,406	2.84
2	134	174	316	224	337	292	1,477	1.23
4	234	5,041	2,609	3,337	826	2,194	14,241	11.87
5	978	5,058	1,745	7,187	1,581	304	16,853	14.05
8	469	489	652	145	5	21	1,781	1.49
9	255	6,982	7,184	8,888	1,980	1,167	26,456	22.05
11	323	34	213	450	650	596	2,266	1.89
12	326	32	6,928	407	418	432	8,543	7.12
16	1,269	938	2,365	4,793	1,253	332	10,950	9.13
17	65	46	1,351	1,008	220	47	2,737	2.28
19	1	2	38	109	24	52	226	.19
20	1	15	394	592	449	171	1,622	1.35
22	268	760	2,713	1,049	1,045	199	6,034	5.03
23	118	17	52	577	362	367	1,493	1.25
25	1	504	45	764	629	350	2,293	1.91
26	6	206	3	44	0	81	340	.28
28	36	74	50	1	93	45	299	.25
29	54	0	131	480	306	460	1,431	1.19
July 1	11	174	279	520	179	0	1,163	.97
2	0	232	613	1,217	38	321	2,421	2.02
4	1	244	0	0	263	199	707	.59
5	27	1	450	210	193	160	1,041	.87
7	1	105	417	683	176	1,095	2,477	2.07
8	627	0	204	494	215	12	1,552	1.29
10	23	97	0	60	0	0	180	.15
11	0	108	226	25	64	1	424	.35
13	206	6	279	488	185	89	1,253	1.04
14	0	82	179	39	0	36	336	.28
16	22	1	118	77	3	85	306	.26
Totals	5,848	22,787	32,840	34,412	13,224	10,854	119,965	100.00
Percent	4.87	19.00	27.37	28.69	11.02	9.05	100.00	100.00
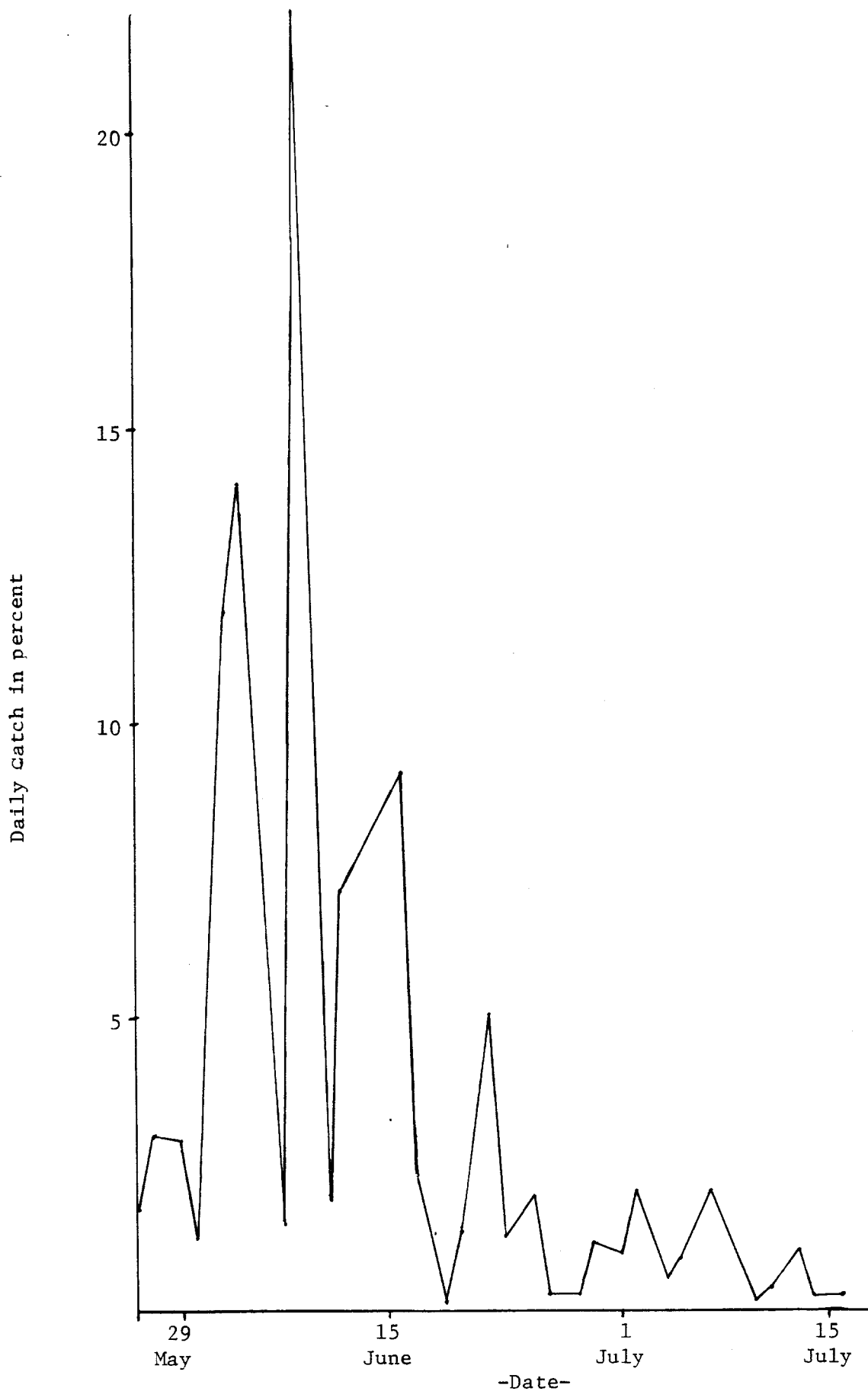
FIGURE 1. Daily random net catches of sockeye salmon smolt in percent of total random catch, Naknek River, 1969.

Index Catch

The index net site, located in swift current in the main smolt migration path, was fished every third night. This site was fished 15 days between May 30 and July 15 to check daily timing of the outmigration (Table 3). Index net catch information was expanded to compensate for days not fished during the season and to aid in estimating total outmigration.

Percentage of smolt caught during and outside the random fishing schedule (random fishing schedule 2100-0600) was 66.93 and 33.07 percent respectively.

Outmigration Estimate

The smolt outmigration was estimated at 11,546,017 in 1969 (Appendix Table C-1). The estimate was derived from methods discussed in McCurdy (1969).

Age, Weight and Length Data

A total of 1,079 smolt samples were collected from the random and index sites to determine age, weight and length by day of outmigration. Twenty samples were collected from sites fished between 2100 and 2400, and twenty samples were collected from sites fished between 2400 and 0600.

Scales were read to estimate daily numbers of Age I and Age II smolt. No Age III smolt were found in the 1969 samples. Age I and Age II smolt comprised 59.83 and 40.17 percent, respectively, of the total estimated outmigration (Appendix Table C-2). Estimated number of Age I smolt for 1969 was 6,907,982 and Age II, 4,638,035 (Appendix Table C-1).

Weights were taken to determine daily condition of outmigrating smolt. Smolt were weighted on an "Ohaus" triple beam balance to the nearest tenth of a gram. Daily mean weights and lengths by age class for the season were derived from the method discussed in McCurdy (1969).

Age I smolt averaged 7.5 grams in weight and 100 mm in length. Age II smolt averaged 12.1 grams and 112 mm (Tables 4 and 5). Age I smolt averaged 1 mm less in length and 1.9 grams less in weight than the 13-year average. Age II smolt were equal in average length and averaged .3 of a gram less than the 13-year average (Appendix Table C-2).

TABLE 3 . Naknek River index net catches of sockeye salmon smolt by 90-minute periods, May 30-June 27, 1969.

90-minute periods	May 30-31	June 2-3	June 5-6	June 9-10	June 12-13	June 17-18	June 20-21	June 23-24	June 26-2
2100-2230	3,541	3,140	6,169	1,794	851	200	0	381	73
2230-2400	3,048	1,200	6,446	4,451	2,638	1,008	57	1,335	67
0000-0130	703	217	2,342	2,039	2,764	530	404	1,316	389
0130-0300	591	197	4,200	8,393	2,567	269	603	577	385
0300-0430	14	187	9,111	4,466	412	163	784	161	44
0430-0600	13	95	3,201	1,536	690	55	592	2	4
0600-0730	43	1,155	2,394	512	77	648	580	12	8
0730-0900	4	243	759[1]/	1,275	400	3,549	313	22	0
0900-1030	3	869	2,485[1]/	4,100	141	553	529	14	0
1030-1200	84	389	765[1]/	1,141	61	790	57	0	0
1200-1330	11	99	1,111[1]/	2,123	32	256	5	0	0
1330-1500	3	108	333[1]/	558	20	32	149	37	0
1500-1630	3	33	258[1]/	482	193	657	40	0	0
1630-1800	11	155	667[1]/	1,179	89	303	782	0	0
1800-1930	154	52	474	1,386	380	897	2,368	0	0
1930-2100	129	27	711	4,484	398	348	900	0	0
Totals	8,355	8,166	41,426	39,919	11,713	10,258	8,163	2,857	970

1/ Interpolated by averaging catches of sockeye salmon smolt caught in the previous and following days.

(Continued)

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TABLE 3. Naknek River index net catches of sockeye salmon smolt by 90-minute periods, June 29-July 15, 1969. (Continued)

90-minute periods	June 29-30	July 2-3	July 5-6	July 8-9	July 11-12	July 14-15	Total	Percent
2100-2230	1	19	17	27	25	20	16,258	11.06
2230-2400	211	192	549	494	127	161	21,984	14.96
0000-0130	645	1,217	276	1,003	370	127	14,342	9.76
0130-0300	480	1,663	121	658	47	70	20,821	14.17
0300-0430	498	446	396	115	28	39	16,864	11.47
0430-0600	963	605	210	137	0	0	8,103	5.51
0600-0730	959	5	414	24	0	0	6,831	4.65
0730-0900	295	0	374	0	0	0	7,234	4.92
0900-1030	4	0	0	0	0	0	8,698	5.92
1030-1200	6	0	0	0	0	0	3,293	2.24
1200-1330	24	0	0	0	0	0	3,661	2.49
1330-1500	69	0	0	0	0	0	1,309	.89
1500-1630	4	0	0	0	0	0	1,670	1.14
1630-1800	0	0	0	0	0	0	3,186	2.17
1800-1930	0	0	0	0	0	0	5,711	3.89
1930-2100	0	0	0	0	0	0	6,997	4.76
Totals	4,159	4,147	2,357	2,458	597	417	146,962	100.00

TABLE 4 .   Naknek River sockeye salmon smolts mean weight in grams, 1969.

Date	Age I			Age II		
	% of total season's catch	Mean weight	% of mean weight	% of total season's catch	mean weight	% of mean weight
May 29	0.43	9.2	0.04	3.65	15.6	0.57
30	2.25	8.4	0.19	4.10	11.0	0.45
June 1	4.03	7.6	0.31	1.06	11.0	0.12
2	1.39	7.2	0.10	1.00	10.0	0.10
4	7.94	7.3	0.58	17.73	12.6	2.23
5	10.57	7.4	0.78	19.24	10.7	2.06
8	1.86	6.2	0.12	.92	10.4	.10
9	18.43	7.0	1.29	27.45	12.1	3.32
11	.47	7.8	0.04	4.00	16.8	.67
12	6.94	7.0	0.48	7.39	12.5	.92
16	12.97	6.8	0.88	3.41	11.8	.40
17	2.19	8.1	0.18	2.41	12.2	.29
19	.14	8.8	0.01	.26	14.0	.04
20	.56	9.3	0.05	2.52	11.1	.28
22	6.93	7.2	0.50	2.19	9.0	.20
23	1.61	7.1	0.11	.70	10.3	.07
25	3.03	7.0	0.21	.24	8.1	.02
26	.44	7.1	0.03	.05	11.2	.01
28	.32	8.8	0.03	.14	11.4	.02
29	1.89	8.2	0.15	.15	12.1	.02
July 1	1.30	9.8	0.13	.48	11.9	.06
2	3.29	8.8	0.29	.13	11.7	.02
4	.94	9.1	0.08	.07	16.2	.01
5	1.38	9.3	0.13	.11	13.6	.01
7	3.19	9.2	0.29	.39	11.2	.04
8	2.11	9.0	0.19	.08	14.5	.01
10	.25	8.9[1]	0.02	.00	-	.00
11	.59	8.8	0.05	.00	.0	.00
13	1.66	10.2	0.17	.13	16.8	.02
14	.47	9.4	0.04	.00	.0	.00
16	.43	9.4[1]	0.04	.00	-	.00
	100.00		7.51	100.00		12.06

[1] Average of previous and/or following day's mean fish weights.

TABLE 5 . Naknek River sockeye salmon smolt, mean length in millimeters, 1969.

Date	Age I			Age II		
	% of total season's catch	Mean length	% of mean length	% of total season's catch	mean length	% of mean length
May 29	0.43	103.5	4.45	3.65	123.2	4.50
30	2.25	102.0	2.30	4.10	110.9	4.55
June 1	4.03	96.7	3.90	1.06	112.7	1.19
2	1.39	96.4	1.34	1.00	106.8	1.07
4	7.94	96.6	7.67	17.73	116.3	20.62
5	10.57	97.1	10.26	19.24	109.1	20.99
8	1.86	91.5	1.70	0.92	107.6	0.99
9	18.43	94.2	17.36	27.45	109.8	30.14
11	0.47	96.3	0.45	4.00	122.6	4.90
12	6.94	93.8	6.51	7.39	114.0	8.42
16	12.97	91.8	11.91	3.41	112.2	3.83
17	2.19	97.2	2.13	2.41	110.4	2.66
19	0.14	98.6	0.14	0.26	117.0	0.30
20	0.56	103.4	0.58	2.52	109.8	2.77
21	-	-	-	-	-	-
22	6.93	96.2	6.67	2.19	101.8	2.23
23	1.61	93.6	1.51	0.70	103.6	0.72
25	3.03	92.6	2.81	0.24	98.0	0.02
26	0.44	93.2	0.41	0.05	93.3	0.05
28	0.32	99.7	0.32	0.14	110.0	0.15
29	1.89	97.9	1.85	0.15	110.0	0.16
July 1	1.30	102.5	1.33	0.48	110.5	0.53
2	3.29	99.5	3.27	0.13	109.0	0.14
4	0.94	98.7	0.93	0.07	120.5	0.08
5	1.38	101.2	1.40	0.11	112.0	0.12
7	3.19	100.9	3.22	0.39	106.7	0.42
8	2.11	99.9	2.11	0.08	118.0	0.09
10	0.25	100.1[1]	0.25	-	-	0.00
11	0.59	100.3	0.59	0.00	000.0	0.00
13	1.66	103.5	1.72	0.13	124.0	0.16
14	0.47	102.0	0.48	0.00	000.0	0.00
16	0.43	102.0[1]	0.44	0.00	-	0.00
	100.00		100.01	100.00		111.80

[1] Average of previous and/or following day's mean fish weights.

DISCUSSION AND COMPARISON WITH PAST DATA

The 1969 smolt outmigration was the progeny of 1966 and 1967 adult escapements. An estimated 6,907,982 Age I smolt were produced from the 1967 parent escapement of 755,640. This is the second largest smolt production from escapements between 600-775,000. The 1966 parent escapement of 1,016,445 produced an estimated 4,638,035 Age II smolt. Smolt production from the 1966 escapement (without Age III smolt included), is the largest from three escapements ranging between 1-1.7 million adults (Appendix Table C-3). Maximum smolt per spawner ratio is achieved with escapement ranges of 550,000 and 800,000 (Figure 2). Above average smolt production was achieved from the 1961 escapement of 351,000 but was omitted as an outlier in determining smolt production. Some variables which affect the ability to achieve desirable escapement levels are: (1) harvest rates, (2) inshore return and (3) weather. Though smolt production decreases with escapements above the 800,000 escapement level, the decrease is gradual. This gradual decrease in smolt production is illustrated in Figure 3. Figure 3 indicates maximum smolt production from escapements of between 800,000 and 1,000,000.

Based on smolt per spawner, smolt production and escapement-return curves, the optimum escapement is approximately 800,000. A desirable escapement range for the Naknek River system is between 700,000 and 1,000,000 adults.

Large escapements tend to produce more Age II smolt than small escapements (Figure 4). This probably is related to variable growth due to intraspecific competition for food at various fry population densities. Production of Age II smolt would probably be more clearly defined in systems comprised of not more than one or two lakes. The Naknek system consists of a series of six lakes. Varying fry to smolt maturity stages probably occurs in individual areas of the Naknek Lake system, contributing to the scatter in the escapement-percentage Age II smolt production relationship shown in Figure 4.

Average Age I and Age II smolt survival rates for the Naknek River system are 12.9 and 20.0 percent respectively (Appendix Table C-4). These survival rates were used to derive the replacement line in Figure 3.

Based on Age I and Age II smolt survival rates, it is apparent that large escapements producing Age II smolt have larger returns. This may be due to the survival rate of Age II smolt to adult.
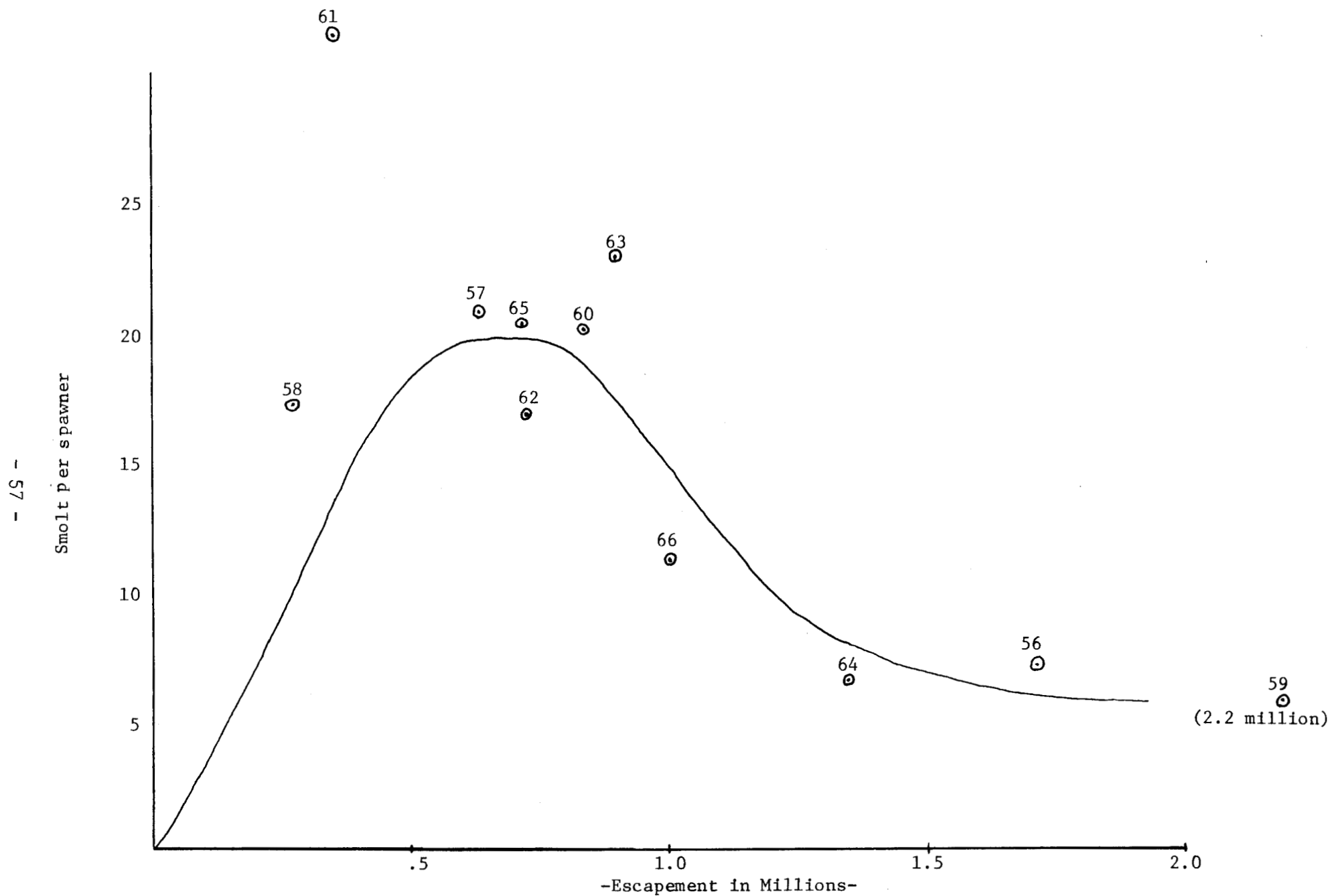
FIGURE 2 . Smolt production from sockeye salmon escapements in the Naknek Lake system, 1956-66. (Reproduction curve is fitted by eye to 3-year moving averages of the paired data, ordered to size escapements).
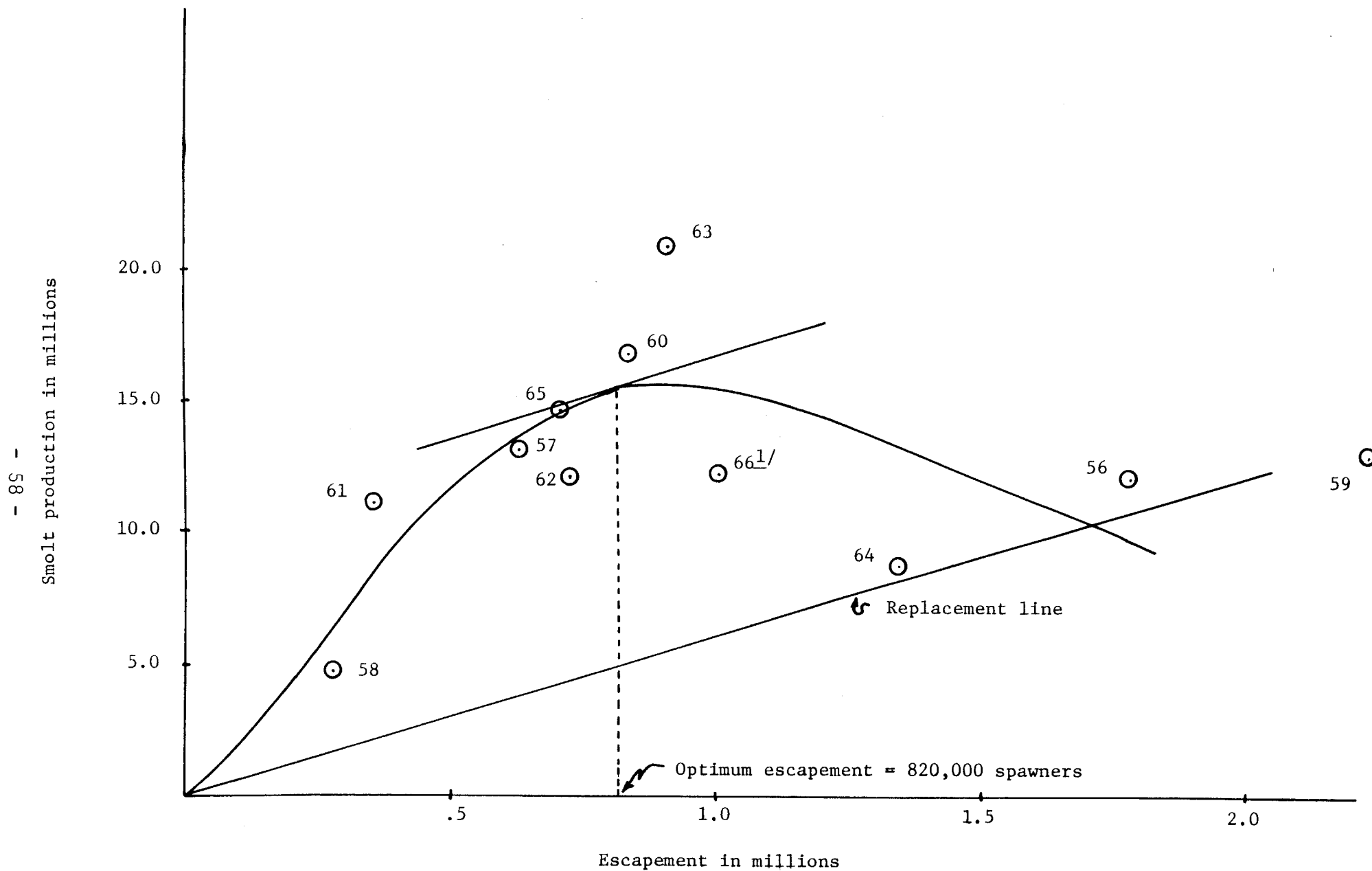
Figure 3.   Naknek River sockeye salmon escapements - smolt production relationship 1956-66[2]/

1/   Does not include Age III smolt.
2/   Production curve is fitted by eye to 3-year moving average of the paired data, ordered
       to size of escapement.
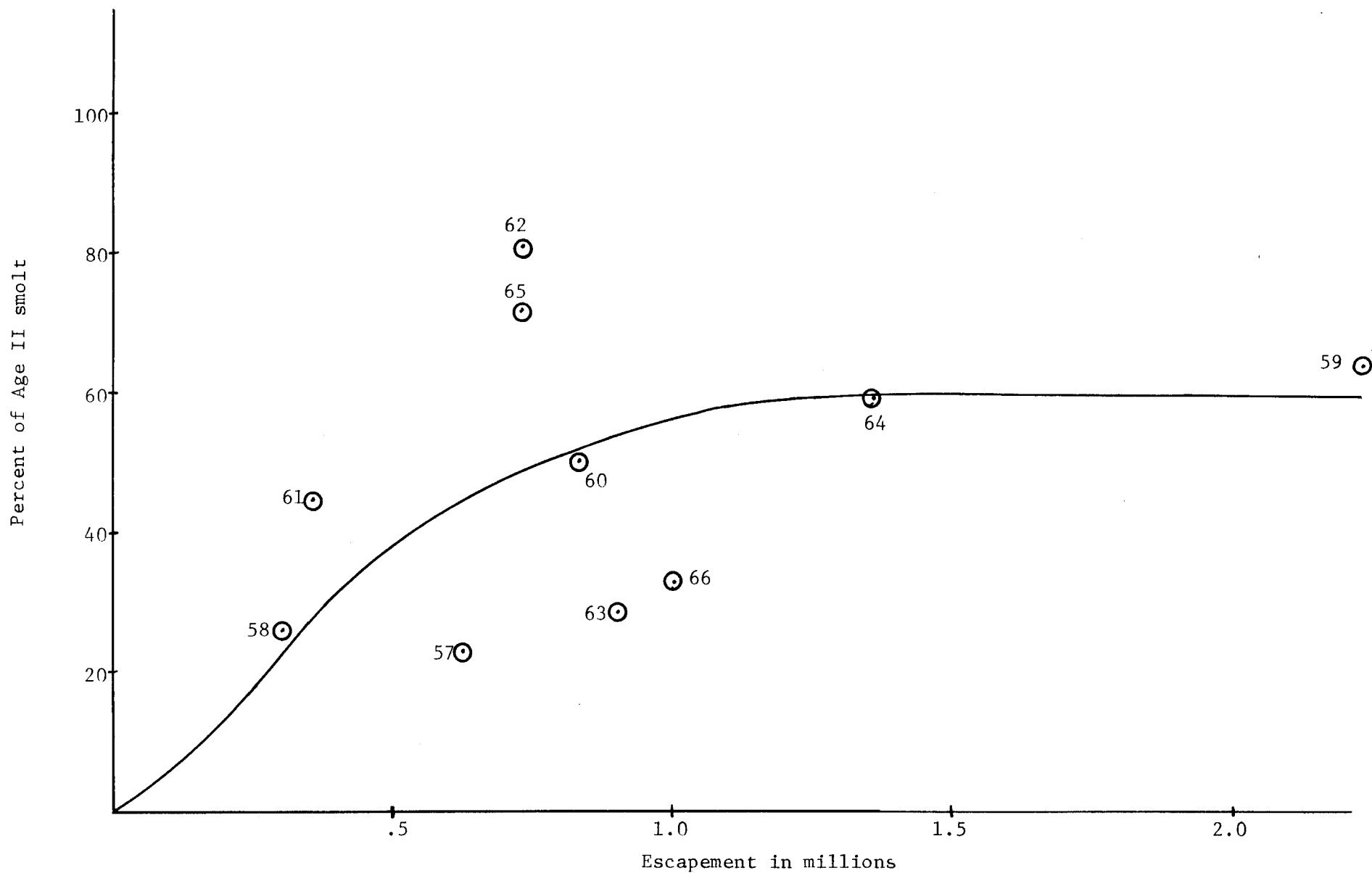
FIGURE 4. Parent escapement and corresponding percent Age II sockeye salmon smolt, Naknek River, 1957–1966. (Curve hand-drawn to 3-year moving averages of the paired data, ordered to size of escapement.)

SUMMARY

1. The 1969 season was the fourteenth consecutive year of smolt enumeration on the Naknek River. The project was initiated by the U. S. Fish and Wildlife Service in 1956. The Alaska Department of Fish and Game assumed responsibility for the project in 1966.

2. Sampling began May 24 and terminated July 16.

3. Peak outmigration occurred between water temperatures of 48° and 53° F. These temperatures were three degrees lower than the past average.

4. Six fishing sites in the main channel of the river were fished on a random schedule during the peak outmigration hours of 2100-0600. An index site was fished 24 hours on every second day of sampling.

5. The peak smolt outmigration day was June 9.

6. Peak smolt outmigration occurred between June 4 and June 22.

7. The total smolt outmigration estimate for 1969 was 11,546,017.

8. A total of 1,079 smolt were sampled for daily age, weight and length.

9. No Age III smolt were in the 1969 samples. Age I and II smolt comprised 59.83 and 40.17 percent respectively of the total estimated outmigration.

10. Estimated number of Age I smolt for 1969 was 6,907,982 and Age II, 4,638,035.

11. Age I smolt average 100 mm in length and 7.5 grams in weight. Age II smolt average 112 mm and 12.1 grams.

12. Smolt production and escapement-return figures indicate the optimum escapement range is between 700,000 and 1,000,000.

13. The point estimate for optimum escapement for the Naknek River system is 800,000.

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1969 EGEGIK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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ABSTRACT

Sockeye salmon smolt outmigration sampling was conducted on the Egegik River in 1969. A single fyke net was fished. Specimens were collected and preserved in 10% formalin solution. Length measurements and scale samples were taken from smolt. Age composition was 31.3% Age I, 65.7% Age II and 3.0% Age III. The adjusted live average length was 88 mm, 119 mm, and 115 mm respectively. Site conditions and equipment made sampling difficult. Ice and algae presented no problem.

INTRODUCTION

In the spring of 1969 an effort was made to collect, by means of a single fyke net, samples from the Egegik River smolt outmigration to determine whether further smolt investigations were feasible and what methods could best be employed. No formal smolt studies have been conducted by the Alaska Department of Fish and Game on the Egegik River. The U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, conducted smolt investigations in 1939, 1956, 1957, 1959 and 1960. Table 1 shows the data for those years.

METHODS AND PROCEDURES

The site chosen for the fyke net operation was the same one used by the Bureau of Commercial Fisheries. The site is located about 1/4 mile up river from the Department's counting tower sites.

The width of the river at this location is approximately two hundred feet. The main channel runs next to the right bank and is seven feet deep

TABLE 1. Average fork lengths by age of Egegik River sockeye salmon smolt[1].

Year	Age I		Age II		Age III	
	Sample Size	Mean Length	Sample Size	Mean Length	Sample Size	Mean Length
1939	–	96.4	–	105.0	–	-0-
1956	14	101.0	249	116.0	123	123.0
1957	17	106.5	202	119.6	17	130.0
1959	80	99.0	190	116.0	11	123.0
1960	27	106.0	130	115.0	2	140.0
1969[2]	21	99.0	44	119.0	2	115.0

[1] DiCostanzo, C.J., U.S. Fish and Wildlife Service,
Bureau of Commercial Fisheries, (Unpublished).

Rodgers, D.E., Fisheries Research Institute, personal
correspondence 11/18/68.

[2] Lengths from preserved specimens adjusted for approximate
live lengths. Collected by ADF&G, measurements and scale
readings by H.W. Jaenicke, BCF.

and seventy-five feet wide.

Due to the lack of proper equipment a six foot fyke net was fished in seven feet of water. The net was anchored in position using a large boulder for one wing line and anchors in tandem were used for the other line. Floats were attached to all ropes and the net to facilitate retrieval and make right observation.

The net was to be fished from 2200 hours to 0200 each night. The net was checked as often as the run intensity dictated. Scale samples, length frequencies, weights and numbers of smolt per pound were collected. Preserved specimens were also collected.

RESULTS AND DISCUSSION

Many difficulties were encountered with this project. Some were due to equipment and others to an unfamiliar project site.

The greatest difficulty was that winds which reached velocities of 40-50 knots made river travel very hazardous and resulted in the loss of several nights of fishing.

The fyke net used in the investigation was old and had rotten netting which tore easily and required extensive mending after each use. The net frame broke at the end of the season.

The sampling equipment was satisfactory except more containers were needed for transporting separate samples to the data collecting station. The smolt age composition from 67 samples on June 13, was 31.3% Age I, 65.7% Age II and 3.0% Age III. The Age I-Age II length frequency is presented in Figure 1. Average length was 99 mm for Age I smolt, 119 mm for Age II's, and 115 mm for Age III's. The separation point for Age I and Age II was 111 mm.
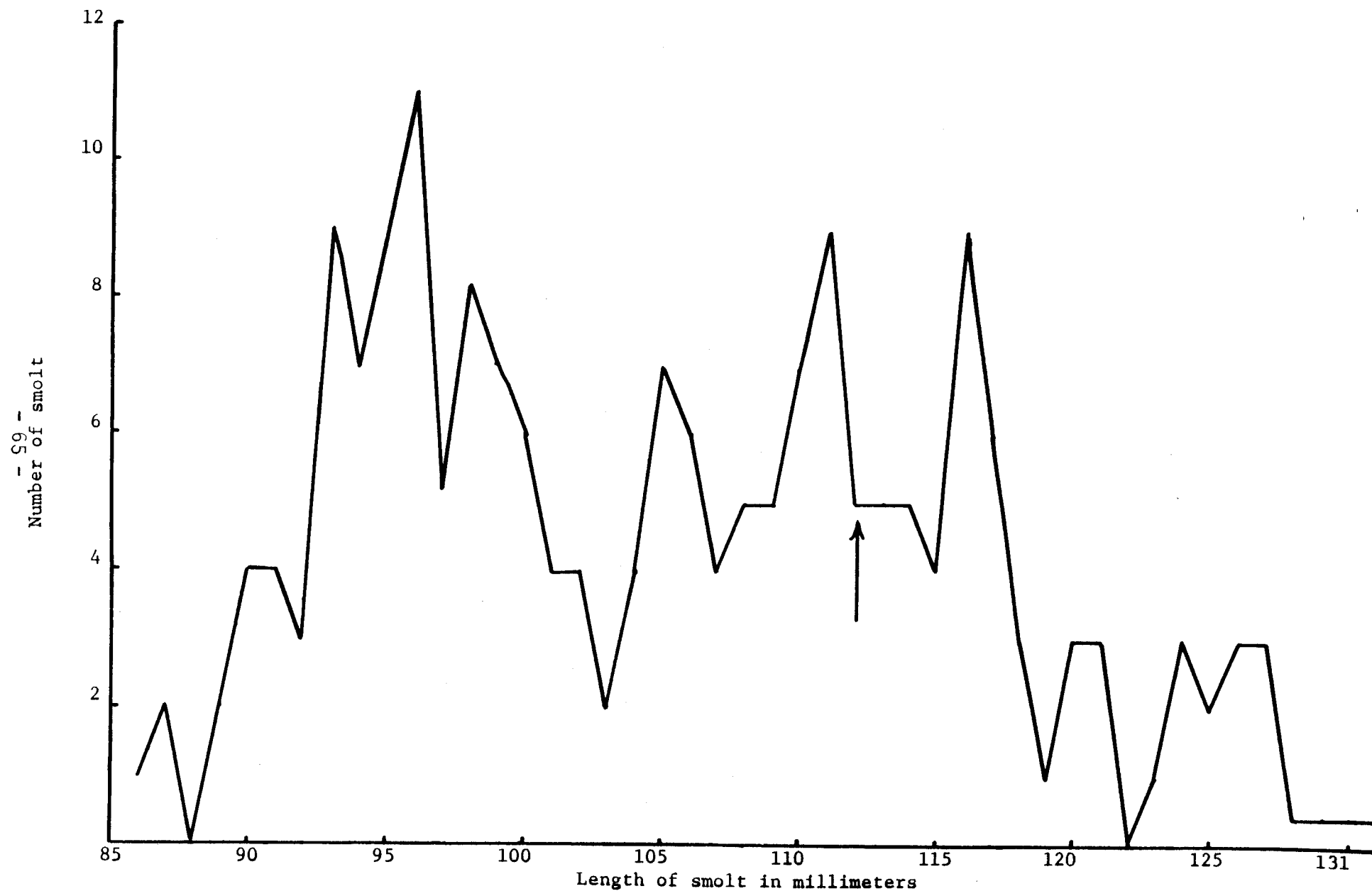
Figure 1. The length frequency of 1969 sockeye salmon smolt preserved in 10% formalin solution. Sample size is 196 Age I and Age II smolt.

1969 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The 1969 Wood River smolt project was conducted by the Bureau of Commercial Fisheries (now National Marine Fisheries Service), in conjunction with a smolt marking project they were conducting for migration and timing studies. The data in this report was taken from smolt collected in a single fyke net fished for 2 hours from 2100-2300 hours. Fishing was conducted at the outlet of Lake Aleknagik from June 14 to July 1.

RESULTS

The total sockeye salmon index catch was 92,813 smolt (Table 1). No attempt was made to expand the catch to previous averages before or after the period fished. The percentage age composition from the 526 scales read (Table 2) was 91.83 percent Age I smolt and 8.17 percent Age II smolt.

DISCUSSION

In 1969, 1,764 smolt were sampled for length measurement. Ordinarily a length frequency is compiled and a breaking point between Age I and Age II smolt is determined. Percentages are then derived and the total index catch is weighted. Due to an exceptionally high rate of growth in Age I smolt the length frequencies of the Age I and Age II smolt coincided. Therefore, the total length frequency percentages were not applicable to the total catch to derive reliable mean lengths and weights as in previous years.

Table 1. Wood River sockeye salmon smolt catch by hour by day, 1969.

Date	Index Hour Catch		Total Index Catch		Index Points[1]	
	9-10 PM	10-11 PM	Daily	Cumulative	Daily	Cumulative
June 14	2,401	7,363	9,764	9,764	5.74	5.74
15	324	10,260	10,584	20,348	6.22	11.96
16	494	152	646	20,994	.37	12.33
17	0	720	720	21,714	.42	12.75
18	105	913	1,018	22,732	.60	13.35
19	0	13	13	22,745	.01	13.36
20	616	3,960	4,576	27,321	2.69	16.05
June 21	6,300	3,555	9,855	37,176	5.80	21.85
22	9,408	480	9,888	47,064	5.82	27.67
23	340	850	1,190	48,254	.70	28.37
24	205	1,148	1,353	49,607	.80	29.17
25	2,236	301	2,537	52,144	1.49	30.66
26	1,334	1,426	2,760	54,904	1.62	32.28
June 27	10,810	2,491	13,301	68,205	7.82	40.10
28	352	1,144	1,496	69,701	.88	40.98
29	2,970	1,530	4,500	74,201	2.65	43.63
30	2,961	3,995	6,956	81,157	4.09	47.72
July 1	376	11,280	11,656	92,813	6.86	54.58
Totals	41,232	51,581	92,813	92,813	54.58	54.58
Percent	44.4	55.6	100.0			

[1] One index point = 1,700.34 smolt.

Table 2. Wood River sockeye salmon smolt sampling data, 1969.

Period	Date	Smolt Catch	Percentage of Season's Total	No. of Fish Measured	No. of Scales Read
1	June 14-20	27,321	29.4	689	206
2	June 21-26	27,583	29.7	591	175
3	June 27-July 1	37,909	40.9	487	145
		92,813	100.0	1,764	526

APPENDIX A

Appendix Table A-1. Dates and water temperatures at beginning of peak smolt
outmigration, Kvichak River, 1955-1969.

Year	Beginning date of peak outmigration	Water temperatures in degrees fahrenheit
1955	June 4	38°
1956	June 1	36°
1957	May 28	42°
1958	May 22	45°
1959	May 26	42°
1960	May 26	41°
1961	May 23	36°
1962	June 1	37°
1963	May 24	36°
1964	June 1	38°
1965	May 24	41°
1966 [1]	-	-
1967	May 26	40°
1968	May 25	40°
1969	May 30	34°

[1] Date of peak outmigration not known for certain.

Appendix Table A-2. Kvichak River 24-hour sockeye salmon smolt catches, average lengths and weights, 1955-1969.

	AGE I				AGE II					
Outmigration	Number	Percent [2]	Average length	Weight	Number	Percent [2]	Average length	Weight	Total number	Total 24-hr. index [1]
1955	18,198	7	89 mm	-	241,780	93	109 mm	-	(259,978) [3]	7.8
1956	30,287	39	92 mm	-	47,373	61	116 mm	-	(77,660) [3]	2.3
1957	22,287	72	96 mm	7.3 g	8,654	28	120 mm	14.4 g	30,907	0.9
1958	3,267,274	98	84 mm	4.6 g	66,679	2	114 mm	-	3,333,953	100.0
1959	85,916	3	80 mm	-	2,777,960	97	99 mm	7.6 g	(2,863,876) [3]	85.9
1960	61,400	10	91 mm	6.3 g	552,603	90	108 mm	10.3 g	(614,003) [4]	18.4
1961	26,038	72	92 mm	6.8 g	10,126	28	117 mm	13.1 g	(36,164) [3]	1.1
1962	1,130,820	94	82 mm	4.3 g	72,180	6	110 mm	9.9 g	1,203,000	36.1
1963	113,338	3	83 mm	4.8 g	4,116,093	97	98 mm	7.5 g	4,229,431	126.9
1964	458,122	22	87 mm	5.2 g	1,603,464	78	108 mm	9.8 g	2,061,586	61.8
1965	64,377	4	90 mm	6.8 g	1,748,178	97	109 mm	11.3 g	1,812,555	54.4
1966	252,384	92	94 mm	7.4 g	23,377	8	114 mm	12.6 g	275,761	8.3
1967	2,866,214	93	86 mm	5.9 g	222,528	7	118 mm	14.2 g	3,088,742	92.6
1968	648,321	11	88 mm	5.5 g	5,475,362	89	104 mm	9.2 g	6,123,683	183.6
1969	594,327	52	92 mm	5.7 g	541,017	48	109 mm	10.6 g	1,135,344	34.0
Fifteen-year averages	602,998	45	88 mm	5.9 g	1,167,158	55	110 mm	10.9 g	1,809,776	54.3

[1] One index point = 33,340 smolt.

[2] Numbers of Age I and Age II fish derived from rounded-off season percentages except in 1963, 1964, 1965 and 1966 when rounded percentages were derived from numbers of smolts obtained by weighting length frequency distribution by daily catches.

[3] 24-hour index catch estimated by ratios with years of actual 24-hour fishing and from visual observations of smolt migration outside the 3-hour index period.

[4] 24-hour index catch estimated from ratios with the 3-hour index period catch obtained during only 2 days of actual 24-hour fishing.

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Appendix Table A-3. Percent of sockeye salmon smolt outmigration occurring during index hours (2200-0100), Kvichak River, 1955-1969.

Year	Outmigration [1]	Percent outmigration during index hours (2200-0100)
1955	259,978	82.3%
1956	77,660	82.3
1957	30,907	82.3
1958	3,333,953	57.4
1959	2,863,876	57.4
1960	614,003	74.1
1961	36,164	82.3
1962	1,203,000	25.1
1963	4,229,431	32.6
1964	2,061,586	38.3
1965	1,812,555	46.9
1966	275,761	39.5 [2]
1967	3,088,742	30.1
1968	2,295,023	37.5
1969	543,351	47.9
Averages	1,515,066	54.4 [3]

[1] The methods used to expand the 3-hour index catches to 24-hour catches for the years 1955, 1956, 1959, 1960 and 1961 are explained in the 1964 smolt report.

[2] This figure is nearly meaningless since ice flow precluded any estimate of comparative migration by period.

[3] Note that the average 54.5% migration during the index hours is probably high as the percent for three of the four years showing 82.3% was assumed on the basis that 82.3% of the smolt in 1957 migrated during the index hours. Sampling was not on a 24-hour basis for the years, 1955, 1956, 1959, 1960 and 1961.

Appendix Table A-4. Kvichak River 3-hour sockeye salmon smolt catches, 1955-1969, (3-hour index catches).

Year of outmigration	Age I Number	Age I Percent	Age II Number	Age II Percent	Total number	Total 3-hr. index [1]
1955	14,971	7	198,897	93	213,868	6.4
1956	24,916	39	38,970	61	63,886	1.9
1957	18,306	72	7,119	28	25,425	0.8
1958	1,874,512	98	38,255	2	1,912,767	57.4
1959	49,292	3	1,593,781	97	1,643,073	49.3
1960	45,478	10	409,305	90	454,783	13.6
1961	21,420	72	8,330	28	29,750	0.9
1962	283,328	94	18,085	6	301,413	9.0
1963	41,424	3	1,339,379	97	1,380,803	41.4
1964	173,919	22	616,623	78	790,542	23.7
1965	34,009	4	816,212	96	850,221	25.5
1966	100,199	92	8,713	8	108,912	3.3
1967	864,650	93	65,081	7	929,731	27.9
1968	252,452	11	2,042,571	89	2,295,023	68.8
1969	282,542	52	260,809	48	543,351	16.3
Fifteen-year averages	272,094	45	497,475	55	769,570	23.1

[1]   One index point = 33,340 smolt.

Appendix Table A-5. Parent escapement and corresponding sockeye salmon smolt production, Kvichak River, 1952-1967.

Year of spawning	Escapement in thousands	24-hour index smolt produced			24-hour index smolt per spawner x 10^3		
		Age I	Age II	Total	Age I	Age II	Total
1952	5,970		241,780			40	
1953	321	18,198	47,373	65,571	57	148	205
1954	241	30,287	8,654	38,941	126	36	162
1955	250	22,253	66,679	88,932	89	267	365
1956	9,443	3,267,274	2,777,960	6,045,234	346	294	640
1957	2,964	85,916	552,603	638,519	29	186	215
1958	535	61,400	10,126	71,526	115	19	134
1959	680	26,038	72,180	98,218	38	106	144
1960	14,630	1,130,820	4,116,093	5,246,913	77	281	358
1961	3,706	113,338	1,603,464	1,716,802	30	433	463
1962	2,581	458,122	1,748,178	2,206,300	178	677	855
1963	339	64,377	24,818	89,195	190	73	263
1964	957	252,384	222,528	474,912	264	233	497
1965	24,326	2,866,214	5,475,362	8,341,576	118	225	343
1966	3,775	648,321	541,017	1,189,338	172	143	315
1967	3,216	594,327			185		
Averages	4,621	642,618	1,167,254		134	211	354

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Appendix Table A-6. Dates of sampling and peak periods of sockeye salmon
    smolt outmigration, Kvichak River, 1955-1969.

Year	Date	Number of days	Date	Number of days	Percent of total catch
1955	5/28-6/27	31	6/4-9	6	94%
1956	5/24-7/4	42	6/1-9, 14-16	12	88
1957	5/28-7/24	58	5/28-6/6	10	84
1958	5/10-7/5	56	5/22-6/3	13	80
1959	5/23-6/28	36	5/26-6/2	8	98
1960	5/18-6/19	33	5/28-6/4	8	80
1961	5/23-6/20	29	5/23-6/2	11	81
1962	5/27-7/4	39	6/2-15	14	88
1963	5/16-6/16	32	5/24-29, 6/7-9	9	86
1964	5/19-6/22	35	6/4-12	9	84
1965	5/17-6/14	28	5/24-30	6	91
1966	5/18-6/17	31	6/4-11	8	97
1967	5/17-6/17	31	5/26-6/6	12	80
1968	5/17-6/14	28	5/24-27, 6/1-6/5	9	76
1969	5/23-6/18	26	5/27-6/5, 6/10-15	14	97
Averages		36		10	87

Appendix Table A-7. Parent escapement and corresponding percent of Age II sockeye salmon smolt produced, 1952-1966.

Year	Escapement	Percent Age II smolt produced [1]
1952	5,970,000	10 - 15% [2]
1953	321,000	72%
1954	241,000	22%
1955	250,000	75%
1956	9,443,000	46%
1957	2,964,755	87%
1958	534,785	14%
1959	680,000	73%
1960	14,630,000	78%
1961	3,705,849	93%
1962	2,580,884	79%
1963	338,760	27%
1964	957,120	47%
1965	24,360,000	66%
1966	3,775,184	45%

[1] Based on 24-hour index catches.

[2] Estimated on basis of 2-ocean returns in 1956 and 5_2 fish in 1957 vs. 5_3 fish in 1957 and 6_3 fish in 1958.

Appendix Table A-8. Parent sockeye salmon escapement and corresponding adult return per indexed smolt, by age group, Kvichak River, 1952-63.

Brood year	Age I smolt				Age II smolt		
	Escapement [1]	Index [1]	Adult return [1]	Ret./smolt	Index [1]	Adult return [1]	Ret./smolt
1952	5,970		17,421		242	3,886	16.06
1953	321	18	136	7.56	47	455	9.68
1954	241	30	108	3.60	9	647	71.89
1955	250	22	358	16.27	67	1,722	25.70
1956	9,443	3,267	30,225	9.25	2,778	7,559	2.72
1957	2,964	86	490	5.70	553	3,527	6.38
1958	535	61	120	1.97	10	169	16.90
1959	680	26	331	12.73	72	220	3.06
1960	14,630	1,131	1,868	1.65	4,116	52,151	12.67
1961	3,706	113	504	4.46	1,604	3,057	1.91
1962	2,581	458	254	0.55	1,748	5,129	2.93
1963	3,775	64	96	1.50	25	936	37.44

[1] In thousands.

Appendix Table A-9. Parent sockeye salmon escapement and corresponding adult return per indexed smolt, Kvichak River, 1952-63.

Brood year	Total smolt		Ret./smolt
	Index [1]	Adult return [1]	
1952			
1953	65	591	8.95
1954	39	755	19.36
1955	89	2,080	23.37
1956	6,045	37,784	6.25
1957	639	4,017	6.29
1958	71	289	4.01
1959	98	551	5.62
1960	5,247	54,019	10.30
1961	1,717	3,561	2.07
1962	2,206	5,383	2.44
1963	89	1,032	11.60

[1] In thousands.

APPENDIX B

Appendix Table B-1. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Ugashik River system, 1956-1969.

Year of seaward migration	Age I		Age II		Index points	Index net catch	Out-migration estimate
	Percent	Mean length in mm.	Percent	Mean length in mm.			
1956	11.0	--	89.0	--	--	--	--
1957	4.0	--	96.0	--	--	--	--
1958	98.1	93.0	1.9	112.0	100.0	301,232	11,659,905
1959	87.3	90.0	12.7	120.0	36.5	109,982	2,887,002
1960	59.7	90.0	39.3[1]/	108.0	75.1	226,317	5,503,646
1961	20.4	90.0	79.6	112.0	52.3	157,441	3,802,079
1962	80.7	88.0	19.3	112.0	103.1	310,616	16,692,089
1963	46.3	89.8	53.7[1]/	104.3	305.2	919,451	33,750,496
1964	80.1	92.2	19.8[1]/	118.3	68.1	205,145	9,990,048
1965	28.8	93.7	71.2	114.1	57.4	172,893	3,640,115
1967	52.5	87.5	47.5	113.1	30.9	93,068	5,137,063
1968	93.1	92.8	6.9	112.6	145.9	439,587	42,205,912
1969	59.7	97.4	40.3	121.2	21.3	63,999	5,048,673

Note: Age group I and II denotes the number of winters spent in freshwater. Age and length are weighted by the index catch.

1/ 1.0 percent Age III in 1960; 0.1 percent Age III in 1963 and 1964.

Appendix Table B-2. Average length and weight of Ugashik River sockeye salmon smolt by freshwater age group, 1958-1969.[1]

Year of seaward migration	Age I		Age II	
	Length	Weight	Length	Weight
1958	93.0	6.4	112.0	11.7
1959	90.0	6.1	120.0	13.5
1960	90.0	6.6	108.0	11.0
1961	90.0	6.7	112.0	12.2
1962	88.0	6.1	112.0	12.3
1963	89.8	6.1	104.3	9.6
1964	92.2	6.9	118.3	12.7
1965	93.7	6.9	114.1	12.5
1967	87.5	6.0	113.1	12.2
1968	92.8	6.5	112.6	10.7
1969	97.4	7.5	121.2	14.5
11-Year total	1,004.4	71.8	1,247.6	132.9
11-Year average	91.3	6.5	113.4	12.1

[1] Weighted by index catch.

Appendix Table B-3. Ugashik River sockeye salmon escapements and smolt production, 1956-1967.

| Brood year | Ugashik River escapements | Millions of smolt produced | | | | Smolt per spawner |
		Age I	Age II	Age III	Total	
1956	425,295	11.4	0.4	0.01	11.9	28
1957	214,802	2.5	2.2	--	4.7	22
1958	279,546	3.3	3.0	--	6.3	23
1959	219,228	0.8	3.2	--	4.0	18
1960	2,304,200	13.5	18.1	--	31.6	14
1961	348,639	15.6	2.0	--	17.6	50
1962	255,426	8.0	2.6	--	10.6	42
1963	388,254	1.0	-- 1/	--	1.01/	--
1964	472,770	-- 1/	2.4	--	2.41/	--
1965	996,612	2.7	2.9	--	5.6	6
1966	704,436	39.3	2.0	--	41.3	59
1967	238,830	3.0	-- 2/	--	3.02/	142/

1/ No outmigration estimate for 1966.

2/ The Age II smolt from the 1967 escapement will not leave freshwater until 1970.

APPENDIX C

Appendix Table C-1. Sockeye salmon smolt migrations, Naknek River, 1956-1969.

Year of seaward migration	Number of Age			Total
	I	II	III	
1956	5,064,000	936,000	–	6,000,000
1957	1,760,401	1,280,015	–	3,040,416
1958	9,698,033	362,167	–	10,060,200
1959	10,034,717	2,430,770	–	12,465,487
1960	3,553,121	3,118,182	20,074	6,691,377
1961	4,366,639	1,246,008	–	5,612,647
1962	8,000,637	8,461,579	–	16,462,216
1963	6,049,747	8,717,000	134,108	14,900,855
1964	2,248,013	4,973,098	7,228	7,228,339
1965	14,741,194	9,878,527	88,951	24,708,672
1966	3,114,885	6,098,025	–	9,212,910
1967	4,096,836	5,284,965	25,399	9,407,200
1968	7,661,568	10,543,954	390,517	18,596,039
1969	6,907,982	4,638,035	–	11,546,017

Appendix Table C-2. Average fork lengths and weights, Naknek River sockeye salmon smolts, 1957-1969.

Year of seaward migration	Age I			Age II		
	% age class	Length mm.	Weight grams	% age class	Length mm.	Weight grams
1957	57.9	111	13.1	42.1	112	13.1
1958	96.4	91	6.9	3.6	114	11.3
1959	80.5	97	8.2	19.5	106	10.1
1960	53.1	99	8.8	46.6	109	11.9
1961	77.8	103	10.8	22.2	113	13.8
1962	48.6	105	10.4	51.4	112	12.5
1963	40.6	98	8.1	58.5	114	12.8
1964	31.1	97	7.7	68.8	110	11.0
1965	59.6	99	8.4	40.0	114	13.0
1966	33.8	106	10.6	66.2	118	14.2
1967	43.5	113	13.1	56.2	119	14.7
1968	41.2	99	8.4	56.7	108	11.1
1969	59.8	100	7.5	40.2	112	12.1
Average	55.7	101	9.4	44.0	112	12.4

Appendix Table C-3. Production of sockeye salmon smolt by brood year, Naknek River, 1955-1967.[1]

Brood year	Escapement	Smolt produced at age			Total
		I	II	III	
1955	278,500	–	362,167	0	362,167
1956	1,772,596	9,698,033	2,430,770	20,074	12,148,877
1957	634,655	10,034,717	3,118,182	0	13,152,899
1958	278,118	3,553,121	1,246,008	0	4,799,129
1959	2,231,807	4,366,639	8,461,579	134,108	12,962,326
1960	828,381	8,000,637	8,717,000	7,228	16,724,865
1961	351,078	6,049,747	4,973,098	88,951	11,111,796
1962	723,066	2,248,013	9,878,527	0	12,126,540
1963	905,358	14,741,194	6,098,025	25,399	20,864,618
1964	1,349,604	3,114,885	5,284,965	390,517	8,790,367
1965	717,798	4,096,836	10,543,954	0	14,640,790
1966	1,016,445	7,661,568	4,638,035	– [2]	12,299,603
1967	755,640	6,907,982	– [3]		

[1] Production from 1953, 1954 and 1955 were only partially sampled in 1956 and 1957.
[2] Age III smolt from the 1966 escapement will not leave freshwater until 1970.
[3] Age II smolt from the 1967 escapement will not leave freshwater until 1970.

Appendix Table C-4. Naknek River sockeye salmon smolt marine
survival by age group and brood year,
1954-1964.

Brood year	Age I	Age II
1954	–	243.8[1]/
1955	92.5[1]/	114.6[1]/
1956	21.5[1]/	10.9
1957	3.9	38.6
1958	9.1	61.9[1]/
1959	16.8[1]/	20.7
1960	25.3	22.6
1961	15.9	21.3
1962	13.9	8.8
1963	3.1	17.0
1964	18.9	
Average	12.9	20.0

1/ Points omitted in computed averages.